FEDERAL AVIATION ADMINISTRATION

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ASSOCIATE ADMINISTRATOR FOR COMMERCIAL SPACE TRANSPORTATION

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The Fourth Annual
Federal Aviation Administration
Commercial Space Transportation Forecast Conference

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Tuesday,
February 6, 2001

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The Conference met in the North Ballroom in the Sheraton National Hotel, Arlington, Virginia, at 9:00 a.m., Patricia Grace Smith, Associate Administrator for Commercial Space Transportation, presiding.

PRESENT:

FAA ASSOCIATE ADMINISTRATOR PATRICIA GRACE SMITH
THE HONORABLE SHERWOOD H. BOEHLERT, MEMBER OF CONGRESS
FAA ADMINISTRATOR JANE F. GARVEY
DR. MELCHOR ANTUÑANO, DIRECTOR, CIVIL AEROMEDICINE INSTITUTE
STEVEN BROWN, ASSOCIATE ADMINISTRATOR FOR AIR TRAFFIC SERVICES, FAA
DR. JOHN CLARK, FLIGHT SURGEON, JOHNSON SPACE FLIGHT CENTER, NASA
KELVIN COLEMAN, SENIOR ENGINEER, AST/FAA
PROF. PATRICK COLLINS, SPACE TOURISM ADVOCATE, AZABU UNIVERSITY
LT. COL. BLAISE CORDELL, SPACE POLICY AND PLANS, USAF
MICHAEL DOOK, SENIOR ENGINEER, AST/FAA
GREG FINLEY, DEPUTY DIRECTOR, OFFICE OF SPACE COMMERCIALIZATION, U.S. DEPARTMENT OF COMMERCE
ROBERT HALTERMAN, CHAIRMAN, SPACE TOURISM DIVISION, STA
TIM HUDDLESTON, CHAIRMAN, NATIONAL COALITION OF SPACEPORT STATES
CHUCK LARSEN, SENIOR ENGINEER, AST/FAA
JOHN MADDEN, FAA ALASKA REGIONAL OFFICE REPRESENTATIVE

DR. VICTOR SCHNEIDER, RESEARCH MEDICAL OFFICER, NASA HEADQUARTERS

ALBERT SMITH, EXECUTIVE VICE PRESIDENT, LOCKHEED MARTIN CORPORATION

ALBERT SOFGE, EXPENDABLE LAUNCH VEHICLE INTEGRATION MGR., NASA

MICHON WASHINGTON, FAA/AST, ENVIRONMENTAL SPECIALIST

DAY ONE AGENDA

OPENING REMARKS: Patricia Grace Smith, Associate Administrator for Commercial Space Transportation, FAA

INTRODUCTION OF FIRST SPEAKER: Jane F. Garvey, Administrator, Federal Aviation Administration

DIALOGUE WITH THE CHAIRMAN: The Honorable Sherwood H. Boehlert, Chairman, Committee on Science, U.S. House of Representatives

KEYNOTE SPEAKER: Albert Smith, Executive Vice President, Space Systems, Lockheed Martin Corporation

Panel One: Space Tourism

Panel Members:
Prof. Patrick Collins, Azabu University, Japan; Advocate, Space Tourism
Robert Halterman, President, Space Tourism Division, Space Transportation Association
Moderator: Michon Washington, AST/FAA

Panel Two: Aviation and Space Interface

Panel Members:
Steven Brown, Associate Administrator for Air Traffic Services, Federal Aviation Administration
John Madden, Alaska Regional Office, Federal Aviation Administration
Moderator: Kelvin Coleman, AST/FAA

LUNCHEON SPEAKER: Timothy Huddleston, Aerospace Advisor to the Governor of Alabama, Chairman, National Coalition of Spaceport States

Panel Three: Space Medicine

Panel Members:
Dr. Melchor Antuñano, Director, Civil Aeromedical Institute, Federal Aviation Administration
Dr. Victor Schneider, Headquarters, National Aeronautics and Space Administration
Dr. Jonathon Clark, Johnson Space Flight Center, National Aeronautics and Space Administration
Moderator: Chuck Larsen, Senior Engineer, AST/FAA

Panel Four: Evolution of Launch Range and Base Management

Panel Members
Lt. Col. Blaise Cordell, Space Policy and Plans, U.S. Air Force
Kelvin Coleman, Senior Engineer, AST/FAA
Greg Finley, Deputy Dir., Office of Space Commercialization, DoC
Albert D. Sofge, Expendable Launch Vehicle Integration Mgr. NASA
Moderator: Michael Dook, Senior Engineer, AST/FAA

CONVENE DAY ONE

PATRICIA GRACE SMITH: Good morning. It is with great pleasure and pride that I call to order this Fourth Annual Commercial Space Transportation Forecast Conference. It is good to see so many familiar faces of those whose eyes are on the future and who share my enthusiasm for the promise of space commerce in the 21st Century.

I would be remiss if I did not note the absence of some of the visionary entrepreneurs who have been among the most enthusiastic space participants. The past year has not been kind in some respects to those seeking to advance the technologies of space transportation. The year ahead will be challenging to our industry for some of the reasons we will be examining over the next two days.

We also will be looking at significant opportunities of the future. How we are viewed as a spacefaring nation has much to do with our ability to foster a viable commercial space transportation industry, to serve both national security and economic interests and needs of our nation, and our ability to continue to be the world leader in the technologies that will shape the 21st Century.

This, in turn, will be shaped by our ability to engender an informed citizenry regarding the benefits, conveniences and necessity of advancing our national space capability. There are significant consequences for our economy, national security and quality of life.

Our new President, George W. Bush, has made education a top priority, and rightfully so. We – the collective we with an interest in space – have a distinct opportunity to ensure that space is included in the new curricula for the country. This is essential if we are to have a space-literate nation poised to embrace the further development needed for the U.S. industry to compete effectively internationally. We must recognize, and emphasize, that significant portions of our nation, and the world, will only have access to the latest educational content
through the capability of broadband satellite delivery.

In my view, not enough Americans, including some of our leaders, appreciate the importance that our space capabilities, and the priority placed upon them, have to our world standing and our people's quality of life. That is one of the subjects we will be emphasizing here at this conference, including the release tomorrow morning of the very first comprehensive study of the impact that space transportation will have on our nation's economy. What in fact does space enable? Well, for one thing, economic activity linked to the commercial space industry in 1999 totaled over $63 billion. Commercial space transportation was directly and indirectly responsible for $16.4 billion in employee earnings throughout the United States.

I encourage you to share this report, once released, with as wide an audience as possible.

These facts, in turn, emphasize the responsibility government has to ensuring the viability and competitiveness of our transportation systems, including space transportation, to meet the national

requirements and the interests of consumers. Transportation Secretary Norman Mineta spoke of this in his recent confirmation hearing when he described the government's "responsibility to make sure that we have a transportation infrastructure adequate to meet demand. Nothing so surely restricts competition as inadequate infrastructure capacity."

I believe this statement also argues well for government's attentiveness to the needs of space transportation that the new chairman of the House Committee on Science, Representative Sherwood Boehlert, is here with us this morning. Even more significant, he is here not to announce his agenda, but to engage in a dialogue with attendees to explore the needs and interests of the commercial space transportation industry.

And to introduce Chairman Boehlert, joining us is FAA Administrator Jane Garvey. Administrator Garvey has been with us before at these conferences and has demonstrated her firm commitment to commercial space transportation as an integral and essential component of the FAA and to space as a transportation system of the future.

Jane Garvey has given strong and innovative leadership to the FAA for the past three years and will continue to guide the agency for the remainder of her five year term.

JANE F. GARVEY: It is a pleasure to be here at the Commercial Space Transportation Forecast Conference. I'm pleased to see so many of the leaders of this forward-looking industry.

The conference program clearly demonstrates how forward-looking you in commercial space are — Space Medicine, Space Weather, Space Tourism. These are subjects most Americans do not yet have on their radar scopes, much less in their day-to-day consciousness. Yet, health, weather, and tourism are all concerns of the commercial space industry and of the FAA.

Dr. Mel Antuñano, director of the FAA's Civil Aeromedical Institute, is a leading expert on the medical aspects of space flight. This says much about our commitment to the future.

Dr. Wallace Friedberg, also of the Civil Aeromedical Institute, is a top authority on the effects of "space weather" when we venture beyond our protective atmosphere and magnetic field. This reinforces our commitment.

And here at this annual conference once again we look at the prospects for ordinary citizens to venture into outer space. This tells you the FAA is determined to look ahead, to lead, and to address the key issues.

When I use the words "forward-looking" there is one person who first comes to mind. That is today's first speaker. This is a man who will be increasingly important to our stewardship of commercial space, to the FAA's research and development functions, and to our nation's science community

Last week our speaker gave his first speech as chairman of the House Committee on Science. I like what he said. And Chairman, I hope this is not is in your text for today's remarks, but if it is, it bears repeating!

He told the Universities Research Association:
"I want to build the Science Committee into a significant force within the Congress and, with that momentum, I want to ensure that we have a healthy, sustainable, and productive R&D establishment – one that educates students, increases human knowledge, strengthens U.S. competitiveness and contributes to the well-being of the nation and the world. "

Yes, this is the kind of leader we need. This is who we want to have oversight of our space transportation office as well as a wide array of the most important science institutions and programs serving our country.

Chairman Boehlert — whom I have had the privilege of knowing for some time — was first elected to represent New York's 23rd district in 1982 and was recently reelected to his 10th term. In addition to his role on the Committee on Science, he serves as a senior member of the House Committee on Transportation and Infrastructure and on the Permanent Select Committee on Intelligence.

Chairman Boehlert is known for his commitment to what he calls the three E's — environment, economic development, and education. He is also known as an effective lawmaker who gets things done.

In 1999, Congressional Quarterly named the chairman as one of the 50 most effective lawmakers in Washington. It said he "has a ready command of the facts, and is a forceful debater, one willing to shed the formal trappings of power if he thinks it might help achieve consensus."

On today's agenda, the chairman's presentation is not listed as remarks, but rather as a " Dialogue with the Chairman." This reflects his approach to leadership. He wants to have all the facts, understand the issues, and then work for sound solutions.

Please join me in welcoming Chairman Sherwood Boehlert of the House Committee on Science.

A DIALOGUE WITH THE CHAIRMAN

(Chairman Boehlert expressed pleasure at having the opportunity to addressed the conference and assured the audience that the commercial space industry would have a friend at the House Committee on Science through his chairmanship. He affirmed his great interest in the space sector in general and his appreciation of the importance of commercial space transportation to the economic and national security interests of the nation.

He said that only having been in the chairmanship for a few weeks, he had not had an opportunity to fully familiarize himself with all of the current issues and details concerning the industry. The Chairman said that given that situation, rather than giving a traditional Keynote Speech, he preferred to engage in a dialogue with the audience to help him become more fully informed on those concerns and issues facing the industry, particularly in those areas which may require congressional attention.

He then invited questions or comments from those in attendance, eliciting a number of comments and suggestions regarding different aspects of the commercial space transportation industry and its current state that might be subject to the interest of the Committee on Science.)

MS. SMITH thanked the Chairman for taking the time to attend the opening session of the conference and his thoughtful attention to the interests and concerns of the attendees. She then introduced Keynote Speaker Albert Smith, Executive Vice President, Space Systems, Lockheed Martin Corporation.

ALBERT SMITH:

- Thank you, Patricia. I'm pleased to help open the 4th Annual FAA AST Commercial Space Transportation Conference.

- I am encouraged to hear chairman Bohlert's remarks in support of space and science and our industry as he will be key in setting the future course for the nations science & technology objectives and the key role the space industry plays in furthering those goals

- As the leader of one of the three principal space companies on the planet, I can say that the work done here and the ideas brought forward are extremely important to the future of our business.

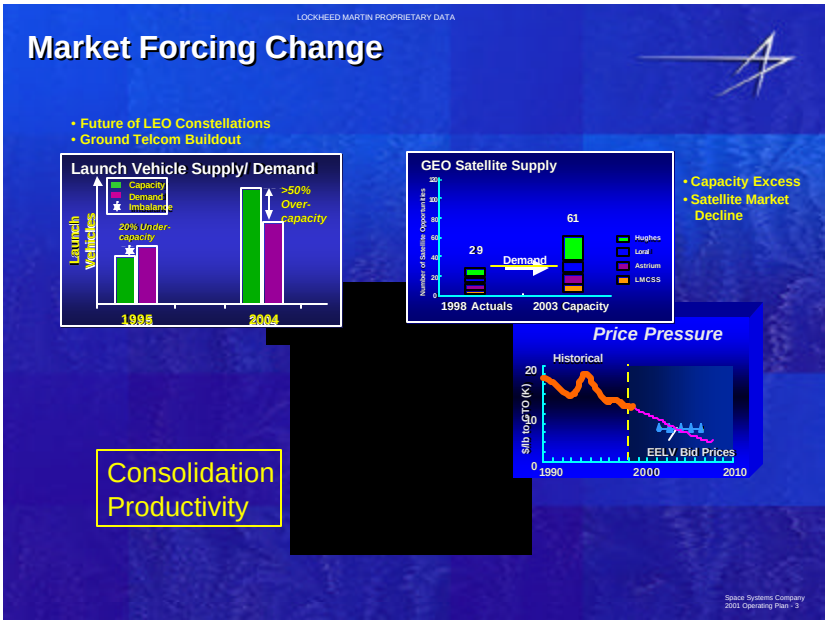
I Would like to make some key points this morning

• First, commercial space is important, has a great future and can represent great growth opportunities, but it is not, in its current state a healthy enterprise

• Second, because our industry is charged first with guarding our nations security and second with promoting commerce, it is important that our government leaders and policy makers support initiatives that assure that the US remain the leader of technology and science

- Third, all space constituencies need to cooperatively work with the government to help expand our international markets

- First on The Health of our industry
- Despite Great achievements, significant issues exist
- US Government funding is strained
- Over-capacity is prevalent



- In the commercial Space business the market place is characterized by too much product and not enough users.

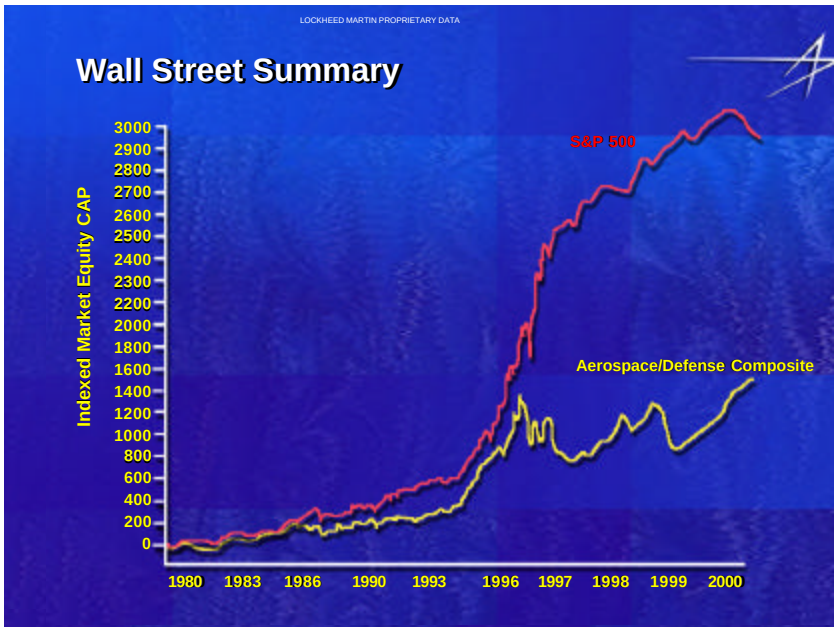
- Overcapacity continues to run greater than 40%

- Prices have fallen by half and profits have suffered as well

- Further Consolidation is the best remedy

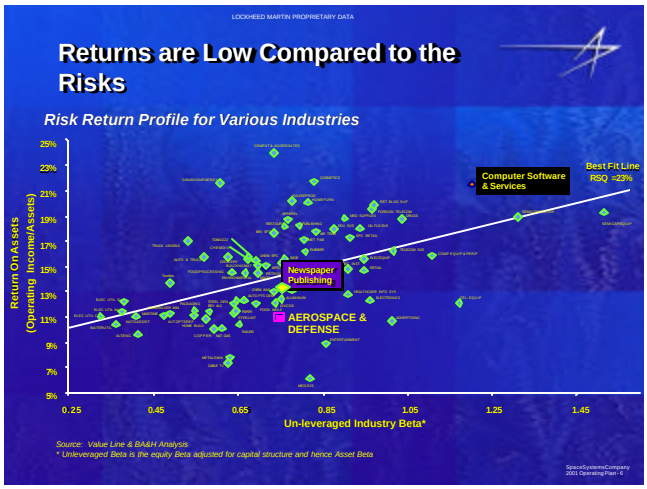
- But current consolidation savings rules make this difficult

- Consequently our performance in the financial markets has suffered



As you can see, aerospace and defense has not kept up with the balance of the country's industrial companies

Hard to believe isn't it



•Our business risk /reward ratios are deplorable. We take an $85M rocket with more than 15,000 separate parts, strap a $300M satellite to it, and through a series of controlled explosions we send it 22K miles away where it has to work perfectly so national security is preserved or commercial communication services are reliably provided

•There is opportunity for calamity throughout the entire trip.

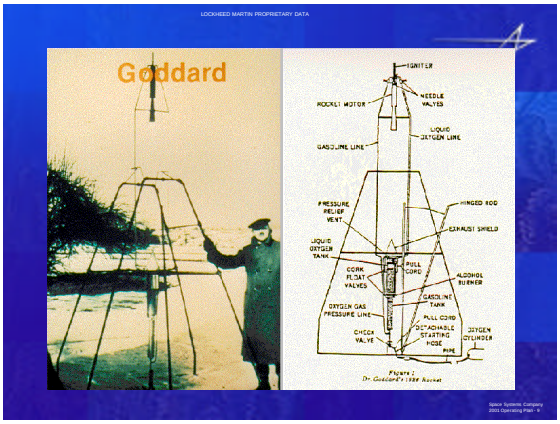
- Pretty precise, risky work..
- We don't expect to make the Dot.Com returns…
- But we would like to do as well as the newspaper business

•Last year the Virtual Reality business did better than $700B in sales

•Incredible growth and profitability over the past 5 years

•Interestingly but not surprising that this same industry has had its pick of the best and brightest of our college science and engineering graduates

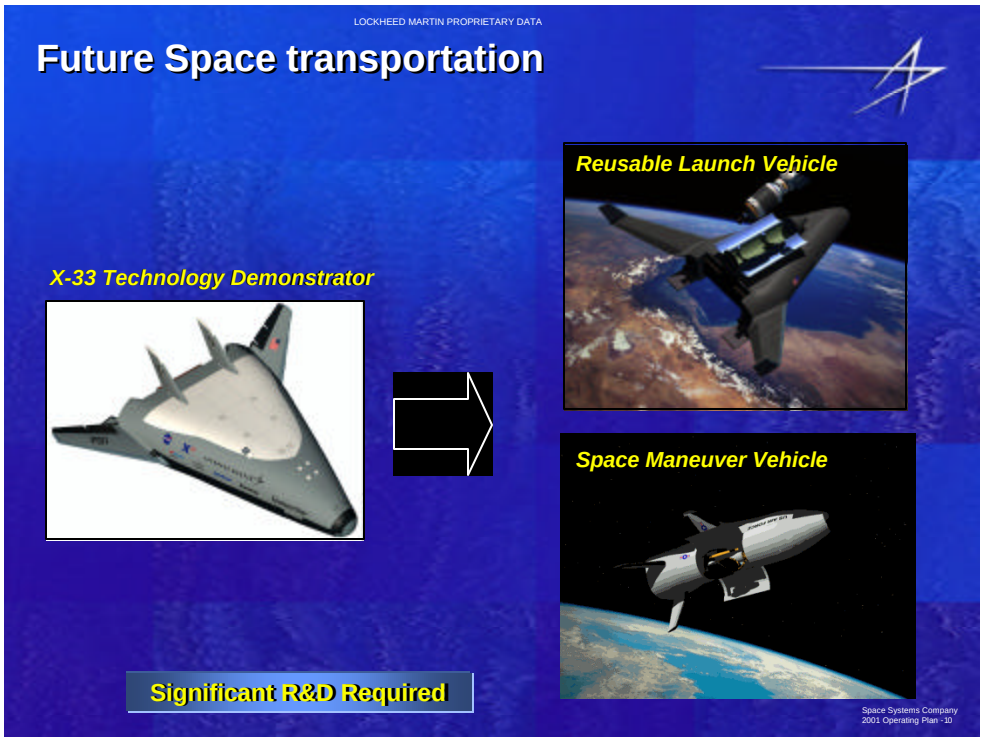
- In contrast… in our business
- Which I assure you is not virtual
- We did less than $100B. And had an incredibly difficult time recruiting science and engineering graduates
- We are beginning to see a slight shift in employment trends that would indicate that more people entering the work force are interested in long term careers vs the promise of instant wealth but we are still having a difficult time recruiting the talent we need
- The new Administration appears to be more in tune with the contributions of this industry & The new Secretary of Defense has industrial base on his agenda



- Investing in breakthrough technologies is risky
- Disruptive discoveries both haunt and intimidate the guardians of the status-quo. Always much to lose & nothing to gain in their minds
- But history teaches us that progress is difficult and breakthroughs don't come without risk and failure

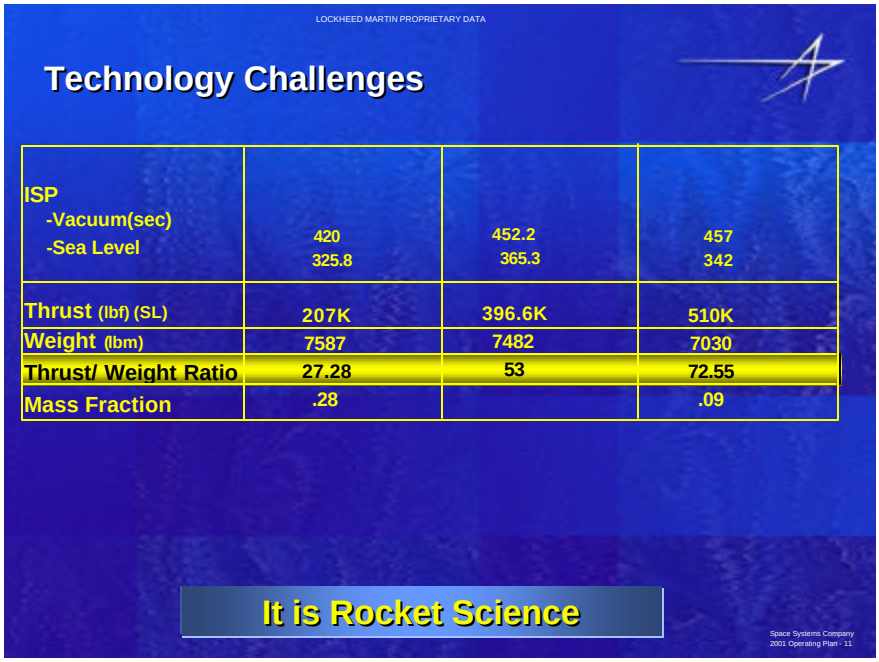
- In 1914, Robert H Goddard having suffered through 2 near-fatal bouts of tuberculosis published his first paper on liquid rocket propulsion
- 3 years later the Smithsonian gave him a grant for $5000 to conduct basic research
- In 1925 he built his first rocket that lifted its own weight to a staggering altitude of 15 ft
- 1n 1935 his rocket achieved supersonic speeds and an altitude of 7500 ft
- In 1941 the editors of Scientific American wrote that Goddard's ideas to use rocket propulsion to convey weapons long distances was
- "too far fetched to be considered"
- In September of 1944 the first V-2 struck the city of London

Goddard had beat the Nazis by 10 years but his breakthrough technology was considered…"too risky"



- Today we are looking at another "risky" venture
- Another whose success threatens the guardians of the status quo
- A revolution in Space transportation is possible
- By what can be demonstrated by x-33
- Lower costs, higher reliability , quick turnaround
- The key , as it was in Goddard's day is
- Materials and propulsion technology
- And once again we risk falling behind
- Because its…" too far fetched" for many

- And funding is scarce



- We invested billions in Shuttle technology to foster reusability and provide return from orbit capability.
- It was not a painless process. Test failures were the rule
- Delays were commonplace
- But the Shuttle became the finest engineering achievement of its time

- X-33 has the potential for breakthrough
- Only Perseverance, courage and a bit more backing are required.

To deal with reduced defense & space budgets we must fill the gap with commercial business if we are to remain viable private enterprises

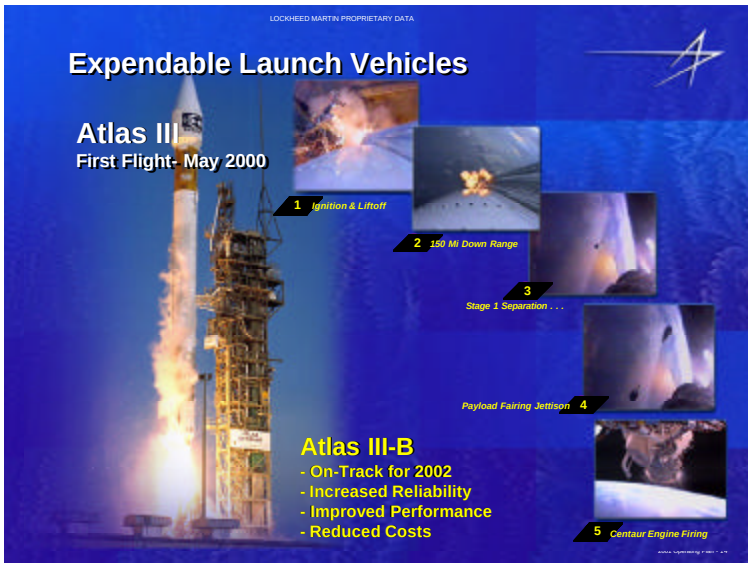
- More than half the future growth in our markets is in the international arena

- But our export control regime is taxed far beyond what it was intended to do..protect national security interests.

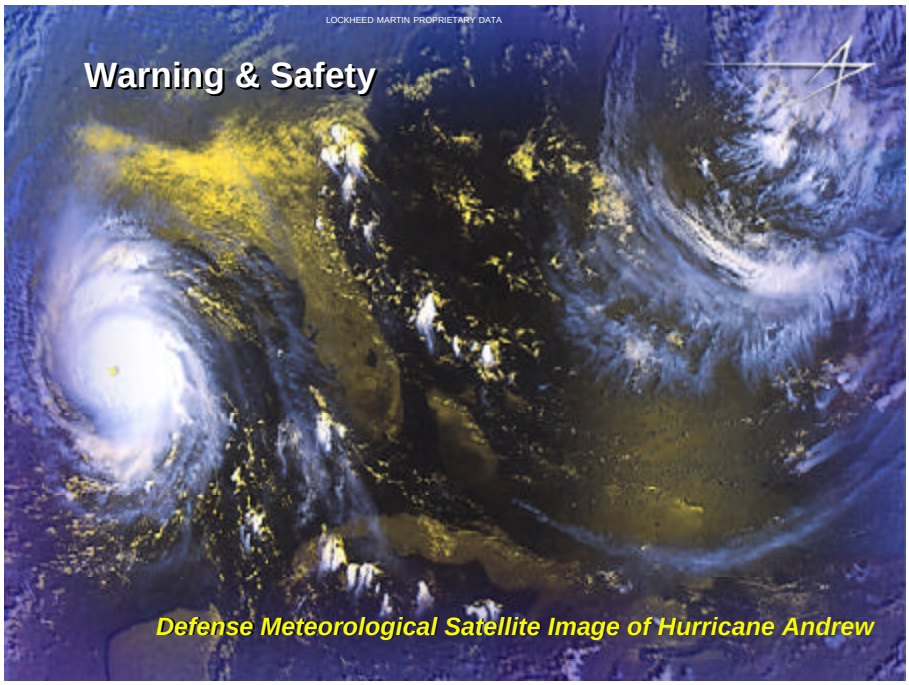
- The transfer of commercial satellite technology to the munitions control list has reversed the carefully orchestrated dual-use philosophy advanced by the Bush administration. This added burden of having to treat commercial satellites as though they were weapons of war has pushed the current system beyond its intended capacity

- We are encouraged that the new administration in being more attuned to our need for a level international playing field & will move forward in streamlining international licensing of our products

- This is a remarkable business
- I have spent my life in this business because I love it
- You don't do it for the Money
- Of the top 500 companies in the U.S., Aerospace CEO's are in the bottom 5th for annual compensation
- We do things no other industry can imagine doing
- We have mastered spaceflight. Last year the US Space Shuttle flew its 100th mission, as part of the process of assembling the International Space Station



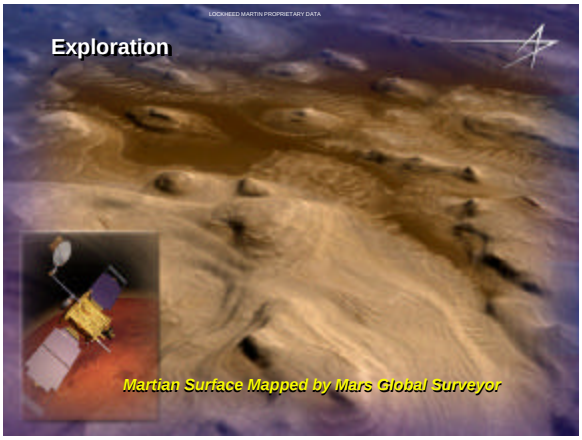
- But it's Expendable launch vehicles that carry the majority of payloads to orbit and beyond
- Last year we launched the first successful next generation ELV, the Atlas III, a continuation of the same Atlas Launch vehicle family that carried John Glenn's Friendship 7 spacecraft to Orbit 39 years ago this month
- To date we have had 54 consecutive successful Atlas launches & Overall Atlas reliability exceeds 97%
- We have launched 198 Titan launch vehicle, the nations space workhorse Beginning with the Gemini program and capped by three successful Titan launches last year
- Titan has an overall reliability of 94%



- We build and operate systems that provide early warning and save lives

- We have launched 88 TIROS and DMSP's. Five DMSP's are in orbit today. DMSP sits in a 800Km polar orbit and takes the highest resolution/ broadest spectrum images of any meteorological satellite fielded

- We make it possible to glimpse at the beginnings of the Universe
- Over 375,000 images have been returned from the Hubble Space telescope in the past 10n years
- This is a view of the Eagle Nebula or
- M-16 (named as the 16th object in Charles Messiers 18th century catalog of "fuzzy" objects)
- The stalagmite looking pillars are composed of densified hydrogen (2 atoms of hydrogen in each molecule) and stellar dust. Within these pillars are even denser masses know as Evaporating Gasseos Globules Many of these EGG.'s are the incubators for new stars that draw their mass from the densified hydrogen.
- This interstellar incubator is 7000 light years or about 41 million-billion miles from earth. For scale the largest column on the left is about one light-year in length or 5.8 Trillion Miles



- We visit other planets and keep the spirit of exploration alive

- In this image taken by the Mars Global Surveyor (MGS) we see the first high resolution topography mapping of Mars This is the Candor Chasma which is part of the Valles Marineris Canyon (similarto the Grand Canyon on Earth).
- We believe this Mission proved that liquid water existed on the surface of Mars within the recent geologic past
- More importantly we now believe that liquid water exists beneath the surface of the planet today.
- We also see evidence of recent geothermal activity as well as predictable weather patterns.
- All of great importance in planning human exploration of the planet.

-MGS completed its mission last Wednesday after completing more than 10,000 orbits of the planet

We help take the mystery out of science and develop a better understanding of our own environment

These trace images of the Sun show solar flare activity Each flare ranges from 25-75K miles high

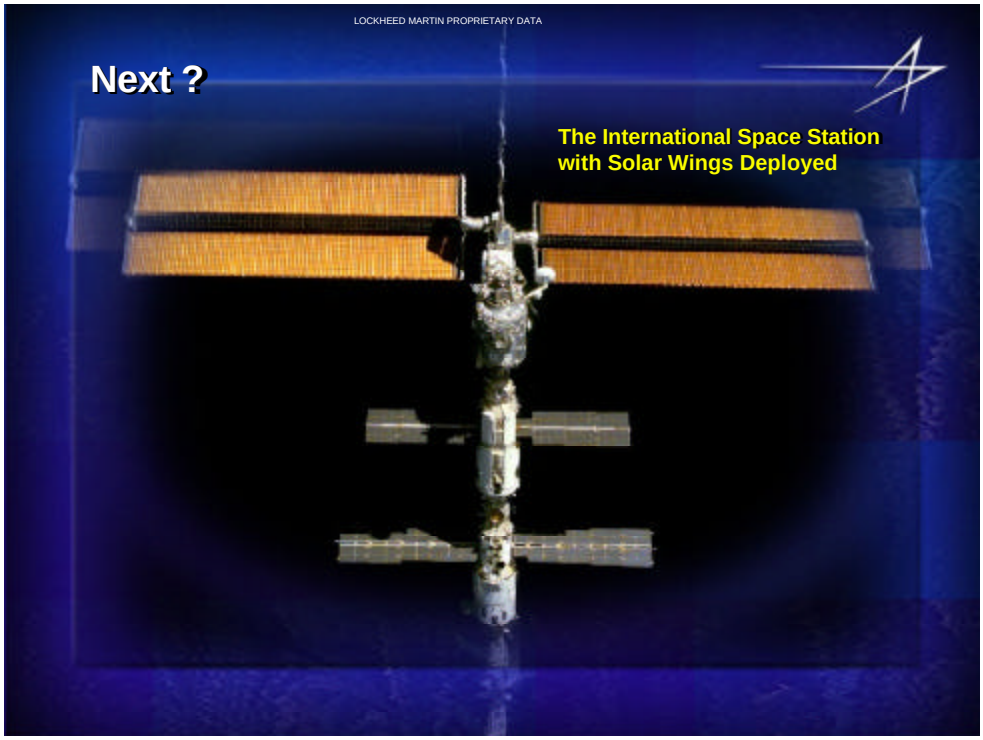
Solar activity generates radiation in the form of solar wind that extends beyond the orbit of Pluto

Each square centimeter of the sun produces the equivalent of 6000 watts of light and the energy received on earth by the sun averages about 1365 watts per square meter

Our sun has about 3-4 Billion years left but only another 500 million to a Billion years until it begins to expand to the point where temps on earth reach 150-200 degrees.. So we need to get going on finding a new place to live

We develop systems that promote whole new businesses. Ikonos is an excellent example of transfer of great technology to the private sector

In communications we enable terabits of data to be transmitted around the world every day. We have helped bring the cost of a long distance call down an order of magnitude. We have expanded the information available to individual homes from 5 channels in 1965 to over 400 today.
Every day we send signals to over 6000 cable companies worldwide and >65M home receivers.



And we make it possible to take the next steps beyond our planet.
In this picture of the ISS, 4 large solar array panels are deployed .

Each array is 112 ft long and 39 feet wide. A total of 8 large solar arrays will be used. When completed the solar arrays will generate 110Kw of power using 250K solar cells or about the same power used by 55 average sized homes. When completed the ISS will be large enough to cover a football field.

Space is truly a remarkable & exciting business.
It can excite the nation & turn imagination into reality.
But our principal mission is to provide a national capability to this country.

I would encourage the country's policy makers to recognize our contributions and our dilemmas.

We have had an incredible partnership, through which we have accomplished the unaccomplishable.

We need to continue the national investment in key space & science technologies & promote science & engineering in our educational systems.

And we need to provide the opportunity to expand our international markets to make turning imagination into reality a viable and attractive enterprise.

Thank you

SUMMARY OF SPACE TOURISM PANEL

The Prospects for Passenger Space Travel
Professor Patrick Collins

Professor Collins began his speech by stating the negative aspects of the current space transportation industry: high costs, low revenue, and taxpayers contributions financing government projects. He then went on to say that he believes that this situation can be changed and that space can become a booming, popular and profitable area of business - a jewel of the world economy instead of a black hole. It was stated that we need appropriate policies that are emphatically not being followed today.

Dr. Collins continued by giving a historical perspective of the aviation industry and how preposterous people thought human flight was before the Wright Brothers' maiden voyage. As a result of this successful flight, the aviation industry is of enormous economic importance today, generating almost $1 trillion in annual revenues, employing tens of millions directly and indirectly. Socially air travel has transformed life on our planet, yet in 1901 the idea of passenger air travel was almost unthinkable. According to Collins, the idea of space travel should be far easier to accept in 2001 because: 1) people have already been traveling to and from space for 40 years; 2) several hundred peoples' experience has shown that there are no significant physiological problems; and 3) the investment required to start passenger space travel is on the order of billions of dollars, not tens of billions as for the government's space program.

It was noted, however, that the opportunities for space travel are not being realized because of the institutional history of the space industry. Government space agencies were set up during the Cold War to compete with the Soviet Union in performing space missions. Space agencies are monopolies that receive relatively loose oversight because they don't supply services to the general public. As a result, they feel little pressure to do what the public wants. Professor Collins then went on to talk about the history of NASA and a report entitled *General Public Space Travel and Tourism*, NP-1998-03-11-MSFC, which explains that space tourism could start at any time and will become the largest business in space and gives a list of recommendations to help bring this about. Despite public promises by the Administrator of NASA this report is not available on NASA's website. Professor Collins presumes that NASA has not made the report available because they do not want the media, politicians, teachers, and the general public to know that we could see the start of passenger space travel services at a public cost of just a fraction of one year of NASA's budget. It is believed that the inaccessibility of this information indicates that NASA is not working for the benefit of the American taxpayer, but for itself - to protect the vested interests in its existing activities and not to achieve economic benefit for the U.S. taxpayers.

The next topic discussed was the potential for growth of passenger space travel. Market research conducted by Professor Collins and his colleagues showed that the idea of passenger space travel is immensely popular: based on his surveys, a majority of the population would like to take a trip to space, and most say that they would pay several months salary to do so. Professor Collins noted that if just 10% of the rich countries' population were to take a single space flight at $20,000 per person, this would represent a market of $2 trillion. Yet more than 50% say they would like a flight and most say they would like to make several trips; moreover, the middle-class population of the world is growing rapidly, so this is surely a serious underestimate of the potential market.

The Japanese Rocket Society is designing a vehicle for passenger travel and estimates that for a investment of approximately $12 billion it would be possible to carry passengers to orbit for about $25,000 per passenger. Professor Collins then went on to give specific details of the Japanese Rocket Society's scenario for developing commercial service by 2010.

Professor Collins spoke of the economic aspect of governments restructuring their space activities to follow the model of the aviation industry. It is his opinion that AST has the right idea - working with the private sector to develop passenger space travel. This approach is thought to achieve great progress in achieving economic value from space activities. He stated that work aimed at developing the largest commercial activity in space is economically far more valuable than work that has no such potential.

As an economist, Professor Collins feels that he has stumbled upon an extraordinary wasted opportunity in passenger space travel and is up against entrenched opposition in the space industry. He discussed how some people think that space tourism is "trivial" but can be viewed by an economist as a consumer service that drives the economy. Aside from the economic considerations, Professor Collins believes that visit space is profoundly educational. In view of the many problems facing our children today, nothing can be more inspiring for them than to be able to realistically aim at traveling in space. The benefits of space travel can only be achieved by making passenger space travel available to the average person. Professor Collins states that tourism in low earth orbit is a key step in leading to further development of space, because it will create a market in space. Where there is a market there is a business opportunity.

Dr. Collins closed his speech by comparing passenger air travel to passenger space travel. He believes that as passenger air travel revolutionized the 20th century, passenger space travel will do the same for the 21st century.

MR. HALTERMANN began his remarks with a prediction that space tourism to the moon is 30-40 years away, provided the right steps are taken now. He considers the STA-NASA General Public Space Travel and Tourism study as a good start. He believes that this study can form a solid basis to identify and

address issues related to the subject and to formulate approaches in reaching the goal of space tourism. He also provided examples of space tourism ventures that developed in response to the study. He added that all such ventures to date involve U.S. funding and Russian systems and infrastructure.

A key recommendation of the Space Travel and Tourism study was the formation of an organizing body to work issues, provide effective resolutions, and identify obstacles and formulate actions to overcome problems. The product of this recommendation, the Space Travel and Tourism Division of the STA, is already on in its way carrying out its mission. The problems and the solutions have been identified. The solutions require all forces (political, financial, technological, etc.) to be applied in solving these problems. A new private-public partnership is critical.

The space travel and tourism investment is a "high-risk, long-term" investment, requiring five-to ten-year periods before returns are realized. The development of the computer, from the first mainframes to today's laptops, is an example of a long-term investment.

Mr. Haltermann emphasized the long-term approach of STA and its determination to devise ways to lower the cost of space transportation by developing a high-volume market. The increasing human population and the continuing interest of space transportation entrepreneurs form a foundation for such a market. The speaker underlined the importance of the education of the new political leadership, which is apparently intent in utilizing space for national defense. STA should undertake the mission to emphasize the importance of commercial space traffic in lowering the costs of such government-sponsored space programs.

NASA, according to Mr. Haltermann needs a new mandate and additional funding to become the guide and facilitator of new less costly and more reliable space transportation systems. Strong NASA leadership, technology successes and uninterrupted funding to the industry by NASA would provide much needed credibility to commercial space entrepreneurs who are searching for private funding for their technologies. A critical mission of STA and the commercial space industry is the education of the new Administration in these issues.

Mr. Haltermann concluded with a "call-to-arms" to all interested parties to work hard and in harmony to re-assess the United States' leadership in space transportation by achieving low-cost and safe space transportation for the public.

(Recess for Lunch)

Chuck Kline, AST Special Assistant for External Affairs, introduced Tim Huddleston, Chairman of the National Coalition of Spaceport States (NCSS) and Aerospace Advisor to the Governor of Alabama. A text of his speech is not available, but he described the NCSS and the reason for its formation.

TIM HUDDLESTON: The National Coalition of Spaceport States was established to actively support the national priority of promoting a timely and competitive commercial space launch industry. It brings together the vast potential of member states to further the development of a nationwide infrastructure of spaceports and space operations. The founding members include Alabama, Alaska, California, Florida, Montana, Nevada, New Mexico, Oklahoma, South Dakota, Texas, Utah, Virginia, Washington, and Wisconsin.

The Coalition defines the term "spaceport" as facilities directly related and essential to servicing spacecraft, enabling spacecraft to take off and land, and transferring passengers or space cargo to or from spacecraft. The facilities must be located at, in close proximity to, or in the direct logistical support path of the launch or reentry site to perform these functions. The term "spaceport" also includes other functionally related and subordinate facilities, such as launch control centers, repair shops, maintenance or overhaul

facilities, and spaceport assembly and storage facilities. These facilities must be located at, adjacent to, or in the direct logistical path of the launch or reentry site.

MCSS intends to take an active role in shaping national space legislation, regulation and policy as it works to promote the development of the next generation of spaceports.

(Reconvene for Afternoon Session)

SUMMARY OF THE "SPACE AND AVIATION INTERFACE" PANEL

The Space and Aviation Interface panel provided insight into some of the key topics and issues surrounding future integration of commercial space transportation operations into the National Airspace System. The panel was moderated by Kelvin Coleman who is project lead for the "Space and Air Traffic Management System" (SATMS) strategic initiative conducted by the Office of the FAA Associate Administrator for Commercial Space Transportation (AST) in partnership with FAA Air Traffic Services (ATS). The panel featured two distinguished leaders from the FAA, Mr. Steven Brown, acting FAA Associate Administrator for Air Traffic Services, and Mr. John Madden, Executive Staff to the Regional Administrator of the FAA Alaskan region.

Mr. Brown, who manages over 35, 000 air traffic controllers, maintenance and software technicians, flight inspection pilots, and administrative personnel who are responsible for the day-to-day operation of the nation's airspace system, provided a "national perspective" on the space and air interface. Mr. Madden, who serves as a FAA liaison with the operator of the Kodiak, Alaska, space launch facility, provided a "regional" perspective on the space and air interface.

Opening

Mr. Coleman opened the discussion by explaining the importance of the need to continue to examine this critical interface as new vehicles and launch/reentry facilities become operational. He stated that in carrying out its responsibility to encourage and facilitate industry growth and international competitiveness, AST has taken on the responsibility to take the lead in initiatives, like SATMS, with the intent being to help clear paths that will allow the commercial space launch industry to move forward. He went on to say that a key partner in the SATMS initiative is Air Traffic Services and that he was proud of the level of commitment that Air Traffic has demonstrated in support of the commercial space launch industry. He recognized Mr. Brown's contributions as a member of the FAA Space and Air Traffic Executive Board, which consists of top senior executives from the FAA Commercial Space Transportation and Air Traffic Services lines of business, the FAA Office of Chief Counsel, and the Air Force. Mr. Coleman concluded his opening remarks by recognizing the contributions made by FAA Air Traffic in the Alaskan region in support of FAA/AST's licensing of the Alaskan Aerospace Development Corporation (AADC) which operates the space launch facility located in Kodiak, Alaska. After Mr. Coleman concluded his remarks, he introduced Mr. John Madden as the first panel speaker.

Regional Perspective

Mr. Madden opened by welcoming the opportunity to speak to members of the commercial space transportation community about activities surrounding aviation and space in the Alaskan region from an air traffic perspective. He mentioned that general aviation constitutes a very large majority of aviation operations that occur in Alaska. Additionally, he stated that many in the region, included pilots and controllers, have welcomed the addition of the launch site at Kodiak and are fascinated by the spectacle of space launch operations.

He mentioned the vastness of the state and the many forms of wildlife that occupy Alaska. He stated that the FAA has done a great job to ensure that the environmental impacts of launches from Kodiak are minimal. He stated that the Alaska Aerospace Development Corporation and the FAA's regional Air Traffic Center have forged a productive working relationship that ensures safety to both people and property on the ground, and the flying public.

John went on to say that the FAA's Alaskan Region issues notices to airmen well in advance of scheduled launches, and prohibits non-participating aircraft to enter into restricted airspace used for a launch. These acts help prevent mishaps or delays from occurring. John closed by stating that the FAA in Alaska looks forward to continuing to work with the commercial space transportation community to ensure safe and efficient operations.

National Perspective

Mr. Brown, opened by stating how valuable discussions with the users are in helping the FAA understand what improvements can be made to make the airspace system work better. He noted that given the changes in the new administration, that the FAA and its customers would be able to enjoy consistency in leadership due to the FAA Administrator continuing in her 5 year term. He also applauded the nomination and appointment of Mr. Norman Mineta as Secretary of Transportation, saying that Mr. Mineta's appointment was "very positive for aviation." He went on to cite Mr. Mineta's reputation as a consensus builder and a forger of public-private partnerships. Steve stated that he was excited to have the opportunity to speak with the representatives and stakeholders in the commercial space transportation industry because the industry is rapidly growing and maturing.

Steve said that he was confident that the FAA could meet the challenge, with the cooperation of both the aviation and commercial space communities, of building the right interface to accommodate both aviation and space transportation. He stated that all users of the airspace depend on the safe and efficient operation of the NAS. He followed by saying that maintaining the NAS in a safe and efficient manner, while providing for future growth in the use of the NAS, is the FAA's top priority. He also said that the FAA is willing to do whatever it can to improve efficiency of the air traffic system, so long as safety is not compromised.

Steve touched on the size and complexity of the US airspace system and pointed out that U.S. domestic passenger growth is expected to grow about 3.6% annually. He expressed confidence that the FAA would be able to handle this growth and meet the growing needs of the commercial space transportation industry. He cited the important role that the Commercial Space Transportation Concept of Operations has played in bringing about awareness of the issues that will need to be addressed in order to provide equitable access to all users of the national airspace. Steve continued by highlighting the fact that cooperation and dialog were and remain to be contributing factors in Air Traffic's ability to take on additional workload, and provide services that are necessary to support launch operations. He stated that he and others in the air traffic community recognize the importance of space transportation to our nation's economy and status as a world leader.

Steve also mentioned that every computer and radar display screen in the 20 FAA en route centers that handle high altitude traffic had been replaced in the last two years. He mentioned that the FAA is also moving towards satellite-based navigation and that new technology using GPS is already helping controllers and pilots keep planes separated in the rural areas of Alaska that lack radar coverage. Additionally, he stated that high tech tools are boosting capacity at major airports like Dallas/Fort Worth, and shaving minutes of flight times that amount to huge costs savings.

Prior to Steve closing, he offered that a member of the commercial space transportation community join the Air Traffic Procedures Advisory Committee (ATPAC), which is the oldest FAA advisory group. He noted the committee's long history in helping to bring about significant changes and improvements in air traffic services and operations. In return, he asked that the Commercial Space Transportation Advisory Committee (COMSTAC) invite a representative from the aviation community to

join as a member. Steve stated that this sort of "cross-fertilization" would help both communities now and in the future. Steve closed by stating that the FAA understands what lies ahead and without constructive collaboration among the aviation sectors we will fall short in our attempt to solve the many complex and overlapping problems that we face now and in the future.

SUMMARY OF SPACE MEDICINE PANEL

Panel moderator Chuck Larsen of FAA's Space Systems Development Division, introduced the members of his panel: Dr. Melchor Antuñano, Director FAA Civil Aeromedical Institute; Dr. Victor Schneider, Research Medical Officer at NASA Headquarters; and Dr. Jonathan Clark, Neurologist/Flight Surgeon at NASA Johnson Space Center.

Dr. Antuñano presented his views on manned commercial space operations in the 21st century dealing with occupant safety issues. He stated the safety of the occupants will be the most important safety issue that the manned commercial space transportation industry will have to address. He gave a history of the FAA Office of aviation Medicine involvement in this issue over the last few years. He identified essential considerations for manned commercial space operations as follows; 1) identify and prioritize the medical and other human factors issues critical to the implementation of a safe manned commercial space transportation system, 2) develop licensing requirements for the operation of commercial space vehicles for the protection and safety of all occupants, and 3) develop medical screening requirements for flight crews and passengers of commercial space vehicles.

He discussed risk factors or safety hazards for the occupants of commercial space vehicles. They included external environmental factors, operational factors in terms of vehicle and flight operations, and individual factors. Some external environmental factors are weather (during the atmospheric phase of flight), barometric pressure, ambient temperature and solar and cosmic radiation. Other external environmental factors he discussed were microgravity and weightlessness, space debris, which is becoming an increasing problem, and post-emergency landing or post-crash survival issues (desert, mountain, jungle and water environments).

Some of the operational factors that he identified were the type of acceleration profile that is experienced and the type of flight profiles flown (ascent rate, maximum altitude, descent rate, duration of flight). Other operational factors include cabin/suit pressure profile and noise and vibration exposure during flight. He discussed operational factors such as breathing air composition, contaminants, CO_2 removal, and volume per occupant. Other operational factors that need to be considered are cabin/ suit temperature/humidity, and impact/crash exposure. Still other operational factors involve physical hazards, injuries due to accidental contact with internal structures or objects, and in-flight fire.

He next addressed individual factors such as unidentified or undisclosed pre-existing medical conditions, self-imposed stress, and unexpected in-flight medical emergencies. Other individual factors include in-flight emergency medical care, space adaptation syndrome, disruptive passengers and space terrorists.

He discussed a number of factors concerning minimum requirements for life support and occupant protection. These factors dealt with pressurization systems for cabin and/or suits, breathing air and air purification systems and ambient temperature and humidity control systems. He talked about acceleration protection systems, vibration and noise protection systems, as well as radiation protection systems. He addressed restraint systems, personal hygiene and waste disposal systems and emergency medical equipment and supplies.

He asked the question and discussed how strict should medical requirements be for space crewmembers and passengers. He discussed main stress factors relevant to development of medical

requirements for space vehicle occupants. These included exposure to acceleration and deceleration, exposure to decreased barometric pressure, exposure to microgravity and exposure to radiation.

He talked about a number of variables to consider such as type of occupant, space flight duration, space flight frequency and flight profile. He discussed medical certification standards for crewmembers in terms of disqualifying medical conditions. Finally he talked about medical screening guidelines for space passengers and research that needs to be done to be able to make decisions about what guidelines and standards can be set to ensure occupant safety.

Dr. Schneider presented his views on "Space Tourism: What Are the Potential Medical Problems People May Suffer While on Vacation during Space Flight". He stated that in the near future it may be possible for people to plan to spend their vacations in space. Currently all space travelers (most of which are career astronauts or cosmonauts) are required to have training for several years and to be certified that they are in almost perfect health. This talk for the FAA conference highlighted the potential medical problems that would occur in vacationers traveling for 3 to 7 days in microgravity.

The human body may react immediately to the lack of gravity with physiologic changes causing such diverse symptoms as dizziness and vertigo, facial puffiness, loss of appetite, disorientation, illusions (thinking that they are moving when they are not or always feeling upside down), and lethargic. Acute potential medical illnesses which may occur include glaucoma, nausea and vomiting or kidney stones. Over the course of the next several days the vacationer may experience muscle atrophy, inability to feel the position of their arms and legs, suffer from the inability to sleep peacefully, continued nausea and vomiting, become dehydrated or have a poor appetite and begin to lose weight.

The physiologic changes in the human include absorbed radiation equaling the equivalent of 3 to 10 whole body x-rays each day of space flight, loss of 20% of the blood volume from the blood vessels, and become deconditioned for exercise on Earth. The latter two physiologic occurrences would show up when the person returned to earth. The returning traveler could suffer from syncope (fainting on standing, during or immediately after any exercise or during that first "hot shower" on return home).

In space the shape of the human body and the internal organs change. The person gets taller and may have terrible back pain from this stretching. The heart and stomach not only change their shape but their location as well. This means that a physical examination in space will be different than on Earth. This may change the type and severity of symptoms for common medical problems.

NASA has had a research program to develop good medical care for space travelers and a dedicated flight surgeon physician group to make sure that space can be a healthy place to work. The medical knowledge used for protecting the astronauts can be used to help space tourists in the future.

Dr. Jonathan Clark gave a talk on "The Medical Risk in Human Spaceflight". He first discussed the risks of space operations. Space flight presents hazards and risks to crew health, performance and safety. With an extended human presence in space expected with expansion of manned commercial spaceflight operations, illness and injury will likely occur on orbit, and may present a significant threat to individual passenger health and possibly to the success of the mission. The hazards of space flight involve the space environment, spacecraft environment and the flight environment.

The space environment hazards include altered gravity, radiation, vacuum, orbital debris and micrometeoroids. The spacecraft cabin environment hazards include atmosphere and life support systems (hypoxia, decompression sickness (DCS), toxic atmosphere, solid and liquid waste contamination), and habitability (confinement, noise and vibration). Microgravity related effects might occur in-flight and/ or post-flight concerns. The flight related issues include psychological effects of isolation and communication access, flight acceleration effects (propulsion, G-forces, impacts), and workload (circadian rhythm disruption and overscheduled activities).

Next, Dr. Clark discussed risk management. A comprehensive crew health program for space travelers should include medical standards, preflight adaptation training, prelaunch preventive medicine

program, on orbit clinical health care (monitoring, diagnosis, treatment), behavioral health, habitability and human factors maintenance, and environmental monitoring. Commercial space tourists may also elect to undergo biomedical research or media coverage to defray costs. Commercial space travelers may also desire post-flight rehabilitation and longitudinal health evaluation.

Dr. Clark then discussed considerations for medical risk analysis. Estimation of risk has been compiled based on U.S. and Russian space flight data, astronaut longitudinal study data, submarine crew data, Antarctic winter-over data, and military aviator data. Four fatalities have occurred in the Russian Space Program, all during reentry (parachute entanglement and cabin depressurization). Ten fatalities have occurred in the US Space program, 7 during launch and 3 in a ground test. Three medical evacuations have occurred from space. Cabin fires, cabin depressurization, toxic atmosphere, and collision have occurred on orbiting spacecraft.

A summary of in-flight medical symptoms for US Astronauts on 89 Shuttle Space missions, derived from post flight medical debriefs and Private Medical Conferences (April 1981 - January 1998) has been compiled. This data covers 508 crewmembers (439 men/ 86%, 69 women/ 14%) ages 28 to 61 years for a total of 4442.8 spaceflight days (3785 days for men, 657.8 days for women). On Shuttle flights 433 of 439 men (98.6%) had symptoms, and 65 of 69 women (94.2%) had symptoms. Space Motion Sickness (SMS) includes malaise, impaired concentration, disorientation, decreased appetite, stomach awareness, nausea, and vomiting, and occurred in 79% of Shuttle crew. Space Adaptation Syndrome includes facial fullness, sinus congestion, headache, and low back pain, and occurred in 42% of Shuttle crew.

In summary, Dr. Clark stated that maintaining a space traveler's health, safety and performance and preventing illness and injury are high priorities necessary for a successful commercial spaceflight. Space travelers should understand the individual risk involved with spacecraft, which are experimental vehicles. The individual health issues that interact with the space flight environment should be understood and mitigated as much as possible. In manned space operations, competition for weight, power, volume, cost, and crew time are often balanced with an individual's health and safety.

SUMMARY OF THE PANEL:
"Space in 2001: Who Will Be Doing What at the Ranges and Why?"

Panel Members:

Greg Finley, Deputy Director of the Office of Space Commercialization, Department of Commerce
Lt. Col Blaise Kordell, Chief of Launch and Commercial Activities, Office of the Assistant Secretary of the Air Force for Space
Kelvin Coleman, Senior Engineer, FAA/AST
Albert Sofge, Expendable Launch Vehicle Integration Manager, NASA
Moderator: Michael Dook, Senior Engineer, FAA/AST

(The panel members reported on the activities of the Interagency Working Group on the Future Management and Use of the U.S. Space Launch Bases and Ranges. Mr. Dook introduced the panel members and gave some background and an overview of the Working Group's activities.)

Mr. Dook: Good afternoon everyone my name is Michael Dook. I am a member of the licensing and Safety Division in the FAA's Office of Commercial Space Transportation. I am please to be the moderator for this afternoon's panel discussion titled "Space in 2001: Who Will Be Doing What at the Ranges and Why?"

That title could lead us to many areas of discussion, as these are exciting times at the U.S. Ranges. We have new state of-the-art range facilities that are nearing completion, new launch vehicle programs like EELV that will begin processing hardware this year, and we are changing the way we do business at the ranges as the commercial use of our ranges continues to increase. But, the focus of our discussion here today will be on the Federal agencies that have a stake in the U.S. ranges. And what those agencies are doing in a cooperative effort to affect change, to affect improvements at the ranges, and to ensure that we have world-class range capabilities, processes, and organizations that support our U.S. space industries while protecting the public and our national interests.

At this time I would like to introduce our panelists. Representing the Department of Commerce is Mr. Greg Finley. Greg is the Deputy Director of the Office of Space Commercialization and as the current Acting Director, Greg serves as principal advisor to the Under Secretary for Technology on space related matters.

Representing the Department of Defense is Lt. Col Blaise Kordell. Blaise is the Chief of Launch and Commercial Activities, in the Office of the Assistant Secretary of the Air Force for Space. Blaise is responsible for developing and coordinating Air Force space launch policy and serves as an Air Force representative to NASA, Executive Branch agencies and the National Reconnaissance Office for space launch matters.

Representing the FAA is Mr. Kelvin Coleman. Kelvin is from the FAA Office of Commercial Space Transportation and a member of the Space System Development Division where his focus has been on space and air traffic management.

Representing the National Aeronautics and Space Administration is Mr. Albert Sofge. Al is currently the Expendable Launch Vehicle Integration Manager at NASA Headquarters. He has held numerous positions with NASA throughout his career including International Space Station Congressional Officer, Kennedy Space Center Associate Director of Safety and Mission Assurance, and Assistant Shuttle Launch Director.

This interagency cooperation that I mentioned has been formalized as an Interagency Working Group led by the White House Office of Science and Technology Policy. I have been fortunate to participate in a number of the working group's activities and I have been asked to fill in on the panel today and give you some background and an overview of what this Interagency Working Group is all about.

The 1994 National Space Transportation Policy says "Assuring reliable and affordable access to space through U.S. space transportation capabilities is a fundamental goal of the U.S. space program." Space transportation is essential to enable all U.S. activities in space. Clear and appropriate roles and responsibilities for the government and the private sector are critical to the ability of all four U.S. space sectors -- military, intelligence, civil, and commercial -- to access space.

Historically, government agencies were the dominant users of the U.S. launch bases and ranges, but in the past decade, U.S. commercial launch rates more than tripled, and they're expected to continue to make up about 40% of the launch manifest on the Eastern and Western Ranges. This increased commercial activity is a success story, but it has strained the current launch infrastructure and raised questions about the viability of the national policy and legal framework that forms the basis for government launch base and range support.

In March 1999 the White House led interagency working group was chartered to:

1. Examine the appropriate division of roles and responsibilities between the federal government and the U.S. commercial space sector;
2. Develop a national strategy for the future management and use of the U.S. space launch bases and ranges; and
3. Recommend any changes to policy, law, or budgets that would be required to implement the national strategy.

The interagency team undertook a yearlong review that resulted in a national strategy and recommendations that were approved by the President in April 2000.

The Report of the Interagency Working Group concluded that although the basic legal and policy framework appears to be adequate to support the current level of government and commercial space launch activity, this framework may require some revisions in the future if the commercial satellite and launch market continues to grow.

It also became clear that the U.S. government is already sharing substantial responsibilities with the commercial sector and is pursuing a path to share significantly more responsibilities with spaceports, state governments, and commercial operators in the future. However, interactions with the U.S. commercial space sector brought to light a variety of concerns.

In response to these concerns, the Interagency Working Group developed a national strategy that builds on the already-planned changes in roles and responsibilities with a series of additional near-term steps that will enhance and expand the government-state-industry partnership. These near-term recommendations are based on our assessment that the U.S. government must ensure access to space for defense, intelligence, and critical civil sector missions and must retain ranges for test and evaluation activities of strategic importance to the United States.

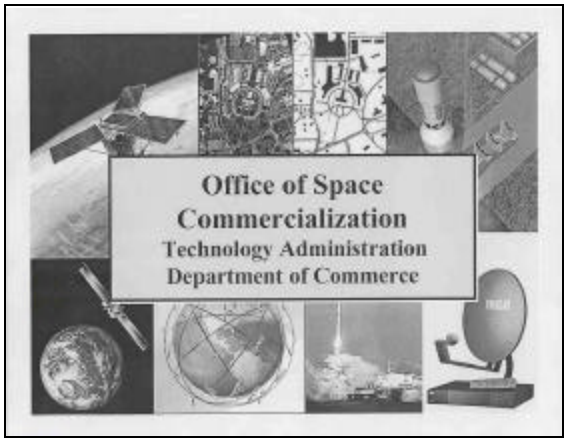
The recommendations address the following 6 points:

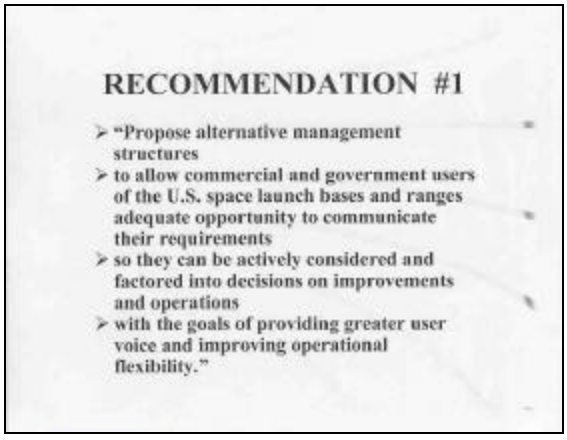
1. Alternative management processes to allow U.S. commercial and government users to have a greater voice in improving operational flexibility.
2. Improving the efficiency of range operations.
3. Use of nonfederal funding where appropriate, especially from states and spaceports, to maintain and modernize the launch bases and ranges to meet national needs.
4. Options for replacing the "excess capacity" construct in the current law to allow a more complete federal-state-industry partnership to develop.
5. Common range safety requirements for government or commercial launches at federal and nonfederal launch sites, including an enhanced FAA-Air Force partnership to formalize their respective responsibilities for safety, and

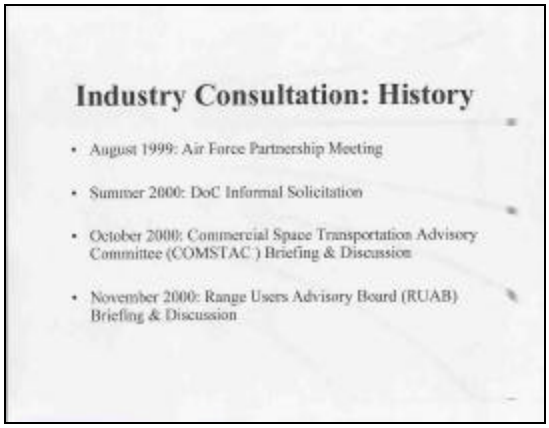
6. Next-generation range technology to improve safety, increase flexibility and capacity, and lower costs for reusable and expendable launches.

Last year at this conference the working group report was released. The panel members that we have with us today will give you a rundown on what has happened in the past year to implement the recommendations and discuss the steps that are being planned for 2001 and the near future.

(Mr. Dook turned the podium over to Mr. Greg Finley from the U.S. Department of Commerce. Mr. Finley's remarks are summarized in the following slides.)







1. Structuring

- Air Force (AF), DoC, FAA/DoT, and COMSTAC plan to agree on an appropriate structure for commercial requirements, involving:
  - Definition
  - Technical and Economic Justification
  - Threshold and Objective Levels

2. Collection

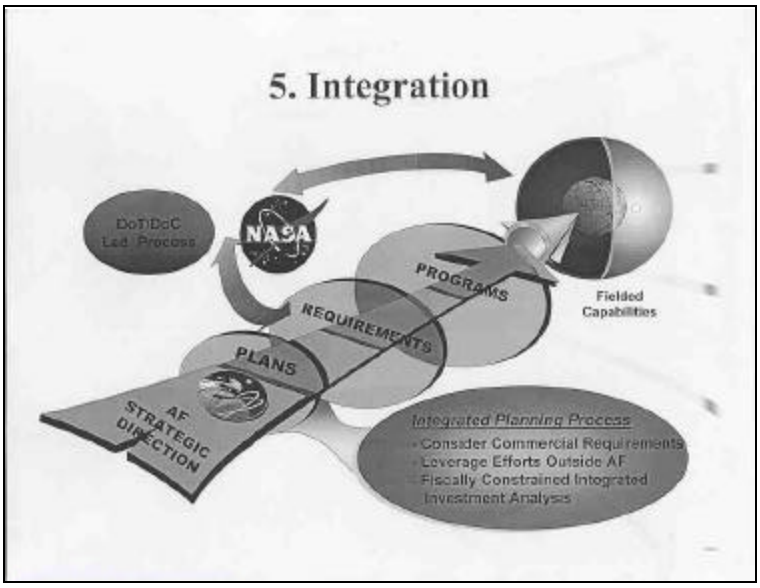
- DoC and FAA/DoT, in cooperation with industry and states/spaceports, plan to continue refinement of the draft commercial requirements list, generated at the 8/99 Air Force Partnership meeting.
- Once initial refinement of the draft requirements list is completed, DoC and FAA/DoT plan to publish it in Commerce Business Daily, for a broad final review.

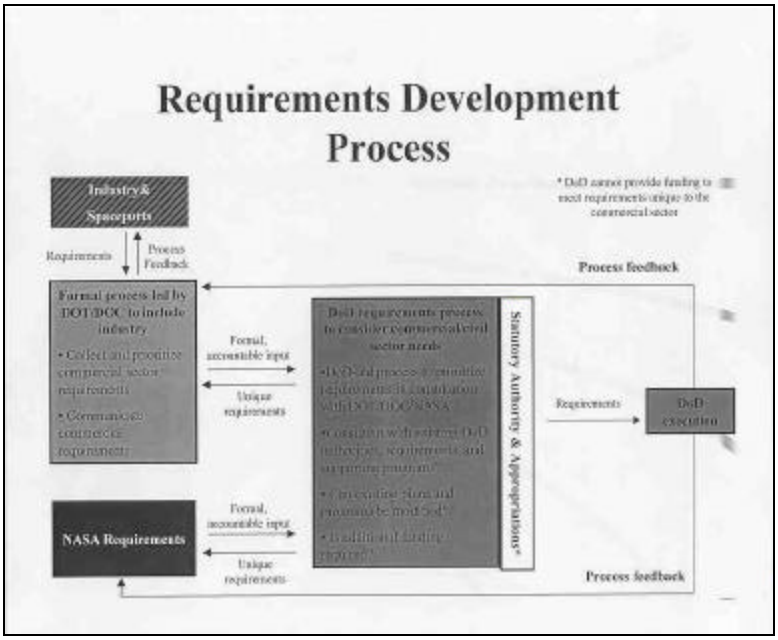
3. Synthesis

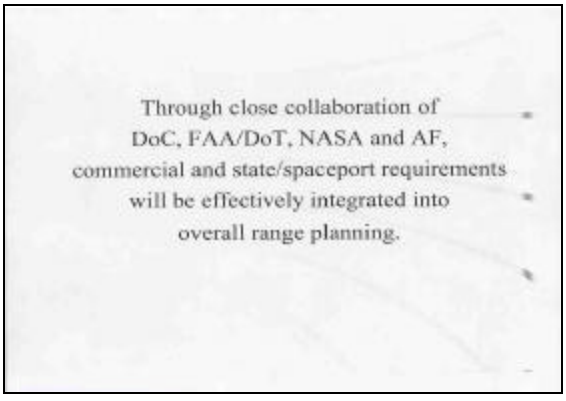
- DoC and FAA/DoT plan to review collected inputs and synthesize them into a consistent set of requirements, conforming to the requirements structure previously determined.

4. Presentation

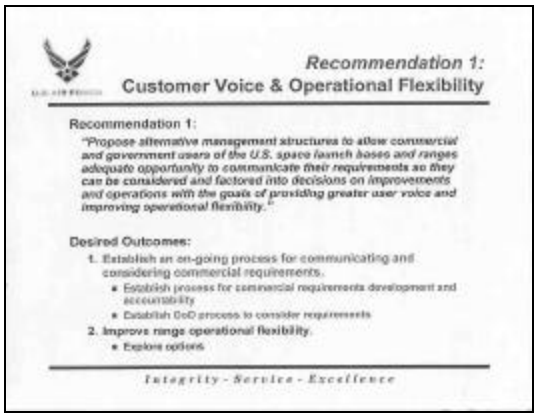
- DoC and FAA/DoT plan to provide a final list of requirements to AF.

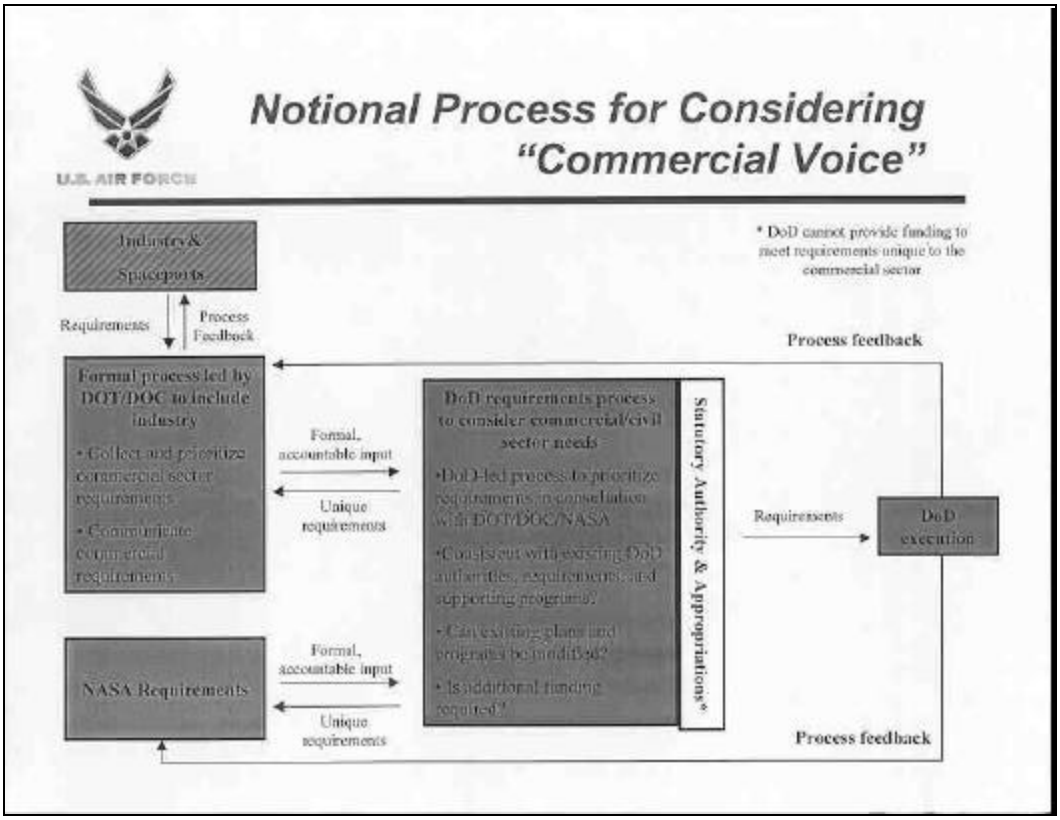

5. Integration
DoT/DoC Led Process
NASA
PROGRAMS
Fielded Capabilities
REQUIREMENTS
PLANS
AF STRATEGIC DIRECTION
Integrated Planning Process
- Consider Commercial Requirements
- Leverage Efforts Outside AF
- Fiscally Constrained Integrated Investment Analysis


Requirements Development Process
Industry & Spaceports
Requirements
Process Feedback
Process feedback
Formal process led by DOT/DOC to include industry
Formal, accountable input
Unique requirements
Statutory Authority & Appropriations*
Requirements
DoD execution
NASA Requirements
Formal, accountable input
Unique requirements
Process feedback


Through close collaboration of DoC, FAA/DoT, NASA and AF, commercial and state/spaceport requirements will be effectively integrated into overall range planning.

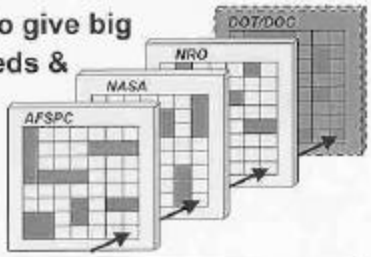
(The next to speak was Lt. Col. Blaise Kordell representing the air force. Lt. Col. Kordell's remarks are summarized in he following slides.)





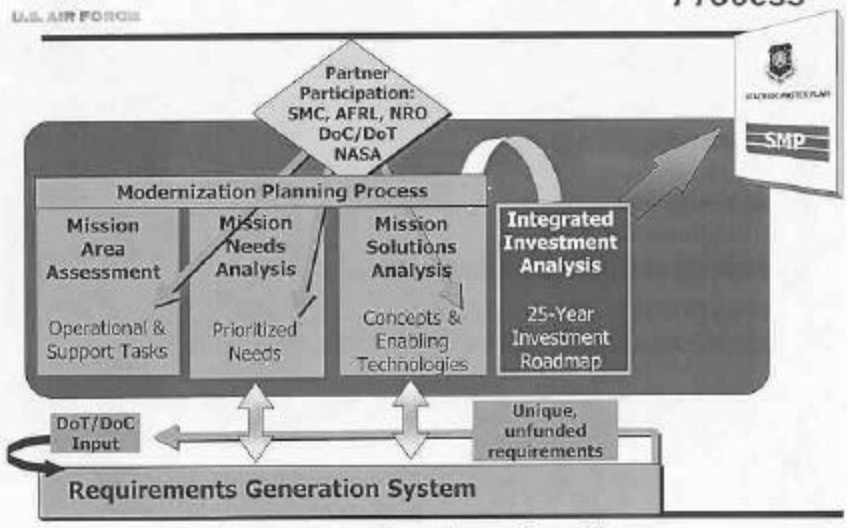
Collaborative Planning

- Propose integration of DOT/DOC process in AF collaborative planning cycle
  - Work with current strategic partners (i.e., NRO, NSSA, NASA)
  - Identify entry point for DOT/DOC input of commercial requirements
- Integration across partners to give big picture view of capability needs & investment opportunities



Integrity - Service - Excellence

AF Modernization/Requirements Process



Integrity - Service - Excellence

Requirements Generation

- Universal Documentation System (Wing Level)
  - Provides common language for stating requirements and preparing support responses
  - Input from individual launch providers
  - Requirements Statements generated to address new capabilities
  - 45, 30 Space Wing have a cost threshold approval authority
- Air Force Space Command Requirements Approval Process
  - Requirements Validation Board provides oversight and advocacy for modifications to AF launch ranges
  - Cost threshold approval authority
- HQ Air Force Requirements Approval Process
  - Modification Review Board, Requirements Review Council, etc.
  - MNS, ORD, etc.

Integrity - Service - Excellence

What does the DoD need?

- Definition: What does the requirement consist of?
  - System and subsystem objectives
- Parameters
  - Key performance parameters
  - Objective and Threshold Requirements for meeting industry needs
- Justification
  - Technical: why is this requirement necessary?
  - Economic: how will this benefit industry?
    - International competitiveness, business case, etc.
  - Priority: how important is this requirement to industry?

Integrity - Service - Excellence

Next Steps Requirements Process

- DOT/DOC…
  - Establishes process to collect commercial requirements
    - Derived from multi-user needs
    - Integrate into consolidated inputs for DoD requirements process
    - Metrics to guide the evaluation and prioritization of inputs
  - Acts as advocate
    - Given opportunities on boards/panels, to state benefits (economic, national interest, etc.)
- DoD…
  - Establishes entry point for commercial requirements
  - DoD adjudicates and determines compatibility with existing and future DoD requirements

Integrity - Service - Excellence

Recommendation 1: Customer Voice & Operational Flexibility

Recommendation 1:

"Propose alternative management structures to allow commercial and government users of the U.S. space launch bases and ranges adequate opportunity to communicate their requirements so they can be considered and factored into decisions on improvements and operations with the goals of providing greater user voice and improving operational flexibility."

Desired Outcomes:

1. Establish an on-going process for communicating and considering commercial requirements.
   - Establish process for commercial requirements development and accountability
   - Establish DoD process to consider requirements
2. Improve range operational flexibility.
   - Explore options

Integrity - Service - Excellence

Improving Range Operational Flexibility

- Range modernization program:
  - Range Standardization and Automation (RSA I) contract complete; RSA II on-track to provide 4 hour range reconfiguration time by 2006 -- enables 24 hour launch-to-launch turn around in EELV era
  - Spacelift Range System Contract awarded, Nov 00
    - $1.3B over 10 years for modernization and maintenance
- Success stories to date:
  - New SATCOM T-1 links to Antigua and Ascension; enabled 2 missions
  - New Fiber Optic Network capable of reconfiguring over 200 circuits in less than 20 minutes; more circuits to be activated in near future
  - New planning system for range scheduling that better meets operator's needs

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Other Range Initiatives

- Implementation of new cost accounting method
- Air Force is conducting launch price audit
- Legislative Changes
  - Excess Capacity (49 USC 701, CSLA)
  - Non-federal investments
- FAA/AF MOA on space transportation safety
- NASA/AF MOA on future range technology

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(Next to speak was Mr. Kelvin Coleman representing the FAA. Mr. Coleman's remarks are summarized in the following slides.)

Space 2001: Who Will Be Doing What at the Ranges and Why?

"Requirements and Resources"

Kelvin B. Coleman
FAA/Space Systems Development
4th Annual Commercial Space Transportation Conference
February 6, 2001

Interagency Working Group

Recommendation:

- Develop common range safety requirements for government, civil and commercial launches at federal and nonfederal launch sites
- Ensure that FAA resources are commensurate with its statutory requirements and safety responsibilities

Desired Outcomes:

- Institute common safety requirements
- Continue to modernize the NAS to account for launch/reentry
- FAA ensure appropriate resources commensurate with its safety responsibilities
- Enhance the FAA-Air Force partnership on safety for commercial launches

Common Range Safety Requirements

- FAA Notice of Proposed Rulemaking (NPRM) for Licensing and Safety for Launch issued for public comment
  - Common Safety Requirements for all licensed launches
  - FAA working with Air Force in rewriting EWR 127-1
- NPRM Comment Period remains open until February 22, 2001
- EWR 127-1 Rewrite, draft document expected to be completed in March 2001

Modernize National Airspace System

- National Airspace System (NAS) Concept of Operations completed (12/00)
  - Basis for NAS investment decisions
  - Addresses all vehicle classes and sites
- Space and Air Traffic Working Council
  - Addresses issues associated with integration of space transportation activities into the NAS
- NAS Architecture shall reflect commercial space transportation requirements

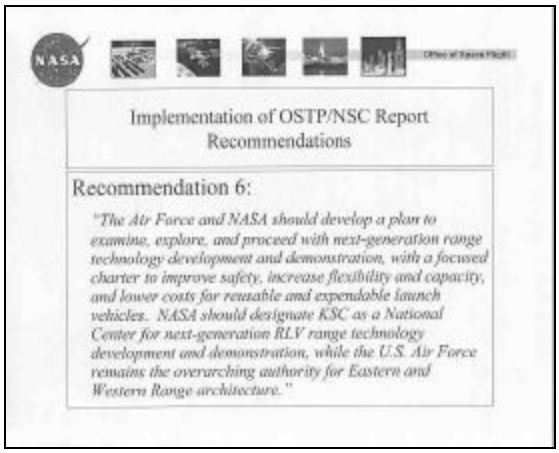
Ensure Appropriate FAA Resources

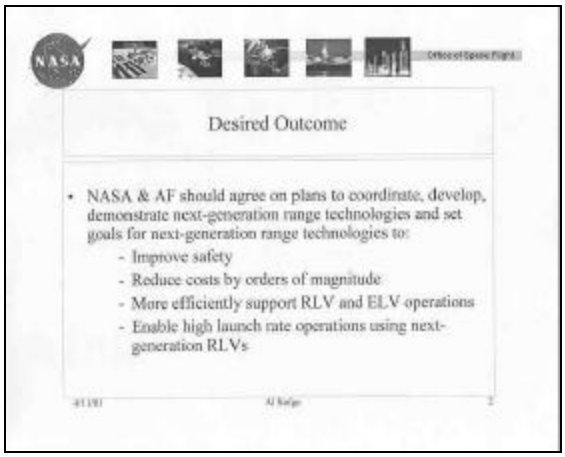
- FAA/AST received $12M in FY 2001
  - 1st Significant increase in 3 years
- AST is currently hiring additional staff to meet its requirements
  - Complete hiring to authorization level in FY01
- Future budget requests will be based on projected needs

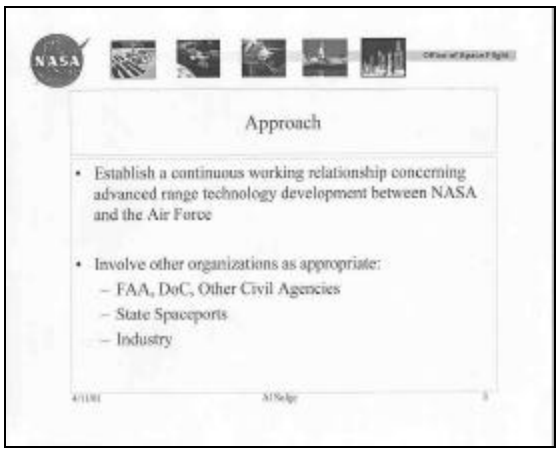
Enhance FAA-Air Force Partnership

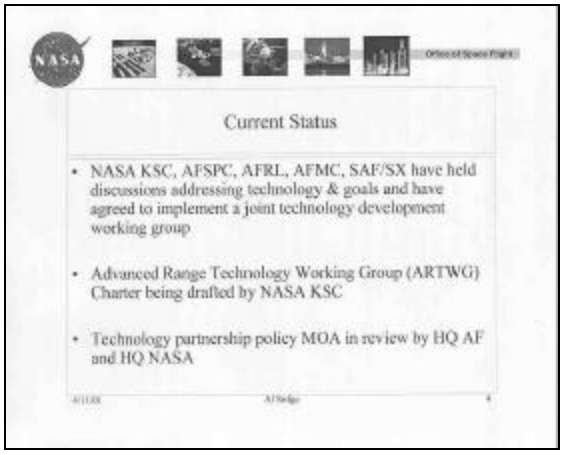
- FAA and Air Force MOA on *Safety for Space Transportation and Range Activities*
  - Formalizes respective roles and responsibilities for commercial space launch and reentry operations
  - Minimizes duplication while maintaining safety
  - Addresses common safety standards, range operations, airspace management, training, & mishaps
- MOA signed 16 Jan by FAA Administrator and ASAF (Space)
  - Available on AST website at http://ast.faa.gov

(The final speaker was Mr. Al Sofge representing NASA. Mr. Sofge's remarks are summarized in the following slides.)









ADJOURN DAY ONE

CONVENE DAY TWO

Wednesday
February 7, 2001

The Conference met in the North Ballroom in the Sheraton National Hotel, Arlington, Virginia, at 9:00 a.m., Herbert Bachner, presiding.

PRESENT:

FAA ASSOCIATE ADMINISTRATOR PATRICIA GRACE SMITH
HERBERT BACHNER, MANAGER, SPACE SYSTEMS DEVELOPMENT DIVISION, AST/FAA
DR. ANTONIO ELIAS, SENIOR VICE PRESIDENT, ORBITAL SCIENCES CORP.
MICHAEL FRENCH, VICE PRESIDENT, ING BARINGS
WALLACE FRIEDBERG, CIVIL AEROMEDICAL INSTITUTE,AST/FAA
KENNETH GORDON, EXECUTIVE DIRECTOR, CENTER FOR SPACE POLICY AND STRATEGY, THE AEROSPACE CORPORATION
RONALD GRESS, MANAGER, LICENSING AND SAFETY DIVISION, AST/FAA
JOSEPH KUNCHES, LEAD FORECASTER, SPACE ENVIRONMENT CENTER, NOAA
CAPTAIN KELLY LAW, SPACE OPERATIONS, USAF
JAMES PAGLIASOTTI, THE AEROSPACE STATES ASSOCIATION
KAREN PONIATOWSKI, DIRECTOR OF ELV REQUIREMENTS, NASA
RANDY REPCHECK, LICENSING AND SAFETY DIVISION, AST/FAA
ESTA ROSENBERG, OFFICE OF CHIEF COUNSEL, FAA
CARL WILLIAMS, STATE PROGRAM/POLICY LIAISON, CSTA/CALIFORNIA SPACEPORT AUTHORITY
STEPHEN WURST, PRESIDENT AND CEO, SPACE ACCESS

DAY TWO AGENDA

Panel Five: Economic Impact of Commercial Space Transportation on U.S. Economy: Release of first study that documents and quantifies the Economic Impact of Commercial Space Transportation on the U.S. Economy. Prepared by the FAA and Futron Corporation.

Presented by:
Herbert Bachner, Manager, Space Systems Development Division, AST/FAA

Reaction and analysis by:
Carl Williams, State Program/Policy .....Liaison, CSTA/California Spaceport Authority
James Pagliasotti, The Aerospace States Association
Kenneth J. Gordon, Executive Director, Center for Space Policy and Strategy, The Aerospace Corporation

Panel Six: Space Weather:

Panel Members:
Joseph Kunches, Lead Forecaster, Space Environment Center,
National Oceanic and Atmospheric Administration
Captain Kelly Law, Space Operations, U.S. Air Force
Doctor Wallace Friedberg, Civil Aeromedical Institute, FAA
Moderator: Ron Gress, Manager, Licensing and Safety Division, AST/FAA

Panel Seven: Economic Issues - Capital: Where Do You Get It and Why Not?

Panel Members:
Michael French, Vice President, ING Barings
Steven Wurst, President and CEO, Space Access
Moderator: Esta Rosenberg, Office of the Chief Counsel, FAA

Panel Eight: New Technologies: What's On The Horizon and Where Will It Take Us?

Panel Members:
Karen Poniatowski, Director of ELV requirements, NASA
Dr. Antonio Elias, Senior Vice President, Orbital Sciences Corp.
Moderator: Randy Repcheck, Licensing and Safety Division, AST/FAA

Convene Day Two

SUMMARY OF THE ECONOMIC IMPACT PRESENTATION AND PANEL

Members of the panel included Mr. Ken Gordon, Executive Director, Center for Space Policy and Strategy, Aerospace Corporation; Mr. James Pagliasotti, Aerospace States Association; Mr. Carl Williams, Program and Policy Liaison for the California Space Transportation Association, California Spaceport Authority.

The following remarks were taken from the presentation on FAA's first study of the economic impacts of commercial space launch industry. The study was made possible with the support and direction of Ms. Patti Smith, Associate Administrator for Commercial Space Transportation, Mr. Brett Alexander who began the project and Ms. Amy Snyder who oversaw its completion in AST, to Futron corporation who developed the methodology and the Satellite Industry Association who provided the raw data from its 1999 industry survey.

We begin with a picture of the use of satellites in daily life. In the morning it's part of the weather report; its use in the internet backbone system; the use of VSAT terminals at the gas station. Later on in the day, satellites are part of personal paging systems and the phone calls that are made. Soon it will be in use as part of the car radio system which will allow stations to be heard coast to coast. In the evening it is part of the direct TV system that is now enjoyed by 15 million Americans.

This study includes the space transportation industry and the industries that it enables, i.e. launch vehicle manufacturing, launch services as well as satellite manufacturing and satellite services.

The information about these industries were captured in a 1999 Satellite Industry Association study which included 700 companies. This data was used in a model that was developed by the Commerce Department called the RIMS II model. This model is not only used to show the impact of economic activity it is also used to forecast the impact of capital improvements on the economy. The model maps the flow of goods and services within the US economy and illustrates the connection between producers and consumers.

Because this is a study of the commercial space transportation industry, government expenditures on space transportation, for example, the Space Shuttle and other military launches were not included in the economic impact report. The definition of US commercial launches are those which are commercially competed and receive a FAA license. A government payload may be included if the launch was commercially competed.

Under most surveys the amount of revenue obtained by the industry is captured. In this study we use multipliers to determine not only the revenue to the last manufacturer but also the revenue received by subsystem and component manufacturers as well as the amount of earnings received by their employees. For example satellite ground equipment, such as a satellite dish has a multiplier of 2.7 which is an indicator of the impact of that purchase on the economy.

There are three measures of economic impact and they are economic activity, the number of people employed and the amount that they earn. The economic activity is the value of goods and services produced by the commercial space industry. The amount of earnings is the earning of people employed in space transportation or enabled industries.

The study shows that the economic activity was determined to be $61.3 billion; approximately 497,000 people are employed and they earned a total of $16.4 billion. The satellite and ground equipment manufacturing combined with satellite services generated the greatest economic activity. The study deals only with economic impacts and does not include other benefits such as being able to gain information faster and having a better quality of life.

The total economic impact for the commercial launch industry and enabled industries is a combination of direct purchases of engines, computer arrays, payments to engineers and workers, indirect payments to purchase components such as wiring, and semiconductor chips including payments to workers producing composite materials and the induced purchases caused by increased consumption of the workers on household goods, entertainment, cars and homes.

The economic activity by industry shows that satellite and ground equipment manufacturing is 50%, satellite services are 42%, while launch services ar 6% of the total economic activity for space transportation and enabled industries.

Americans earned a total of $16.4 billion from the space transportation industry. Of this amount $8.9 billion was generated by the earnings from satellite and ground equipment, $6.2 billion was generated from satellite services, while $1.1 billion was generated from commercial launch vehicle manufacturing.

A total of nearly ½ a million jobs were generated by the commercial space transportation and enabled industries. Jobs were primarily found in the electronics and communications sectors. Jobs were also found in the construction, printing and publishing sectors.

In conclusion, this was the first attempt at this type of study and used a methodology which the FAA has used previously to understand the impact of civil aviation on the US economy. One of the improvements that could be made would be to use regional or statewide studies which could be rolled-up into a nationwide study. Another activity that would improve the study would be better definition of the Commerce Department codes for the model. Finally, we would like to have determined the direct, indirect and induced impact on earnings and jobs, however the model could not provide these breakouts.

The study shows that the space transportation industry generated a great deal of economic activity and that an infrastructure is already in place. It is also a growing industry and worthy of further investment. As investors and state and federal officials make decisions on whether to invest in space activities, this model can be used to provide impact forecasts.

The first person to comment on the study was Mr. Carl Williams from the State of California. Mr. Williams spoke about the California Space and Technology Alliance and the impact of the study. Carl explained that the CSTA is a coalition of industry groups that cut across the full range of space, commercial, civil and military activities in California. Much of the data that has been collected by California as part of their Space Infrastructure Program does not line up with the FAA study, but we can make a rough comparison to validate the FAA study.

California's analysis included commercial, civil and military space activities. It appears from the FAA study however that the groups that are discussed are all located in California. Therefore, we feel that the report reflects something that looks much like California. We believe that California has between 20% to 25% of the $61 billion of the entire industry. We would have like to have seen a state by state breakdown of this study including the geographical locations with respect to the enabled industries. Knowing where the industry centers are located allows us to get our political leaders to encourage space as an industry.

It looks most likely that the commercial industry really is going to be a for-profit industry which lead space development in this country. It is just not possible that NASA and the military will get the kind of appropriations that are going to allow them to do all that needs to be done to develop this industry. In California we see a modest growth over the next three years of 3% in the manufacture of satellites and launch vehicles. However, we see a doubling from $20 to $40 billion in commercial services worldwide. The military will be a major customer of commercial services. The Rumsfeld report encourages the military to be a reliable customer of these services with long term contracts.

In terms of employment in California in 1999 we had about 177,000 employees in direct space related companies, for example Boeing and Lockheed Martin. We also had another 422,000 people

employed in enabled industries for a total of 600,000 people. This would include commercial, civil and military activities. Mr. Williams said that he thought that number would grow if the industry was treated fairly.

California has an average salary of $55,000 a year for employees working directly in the space industry. If you add in the people who are in the service area as well as part time the average salary may decrease to $33,000 which is indicated in the study.

Recently the CSTA conducted a simulation and Ms. Patti Smith was kind enough to participate with us. From that experience we learned that top elected officials need to issue a space policy that reflects the public's support for the industry. Secondly, based on that policy the state agencies must include a space element with budgetary authorization to support the space industry. Third, we need a dynamic space strategy with realistic objectives and goal for the state and a commitment of resources. Fourth, there needs to be a political consensus to create partnerships and alliances. Finally, California needs to extend its leadership to influence the new national space agenda under the Bush administration.

The next speaker was Mr. Jim Pagliasotti from the Aerospace States Association. Mr. Pagliasotti state that he was glad to see the report as they were often asked for these types of statistics. There has been a long working relationship between the Aerospace State Association and the office of Commercial Space Transportation. Mr. Pagliosotti then discussed the development of the Aerospace States Association and his participation in the volunteer association. He said that in the early 1990's the draw down of the defense establishment concerned a number of State Governors. The department of Commerce of the State of California stated at that time that the state had lost 600,000 high tech jobs. The jobs in those days were centered in Florida, California, Alabama, and Texas – wherever NASA had a field center. People did not think of the nation as a whole, however, some governors were beginning to realize the future impact of space.

Colorado has had a leadership role in the development of new technology. The first element was the development of the cable company, TCI . Jim said that he learned from the President of TCI the benefits of satellite communications. But telecommunications is really the first step in the use of space and other states need to be convinced of the need for space activities. Therefore, ASA is a voice for the states in dialogue with federal policy makers. It appears now that commercial space development will be the third leg of a stool which already has civil and military activities.

Governors are concerned about jobs, education, and the quality of life including public safety. Commercial space activities have made up for some of the jobs lost in the draw down of the 1990's, the constrained NASA budgets as well as improving our education opportunities. Colorado was severely impacted in the early 1990's because most of the industries were in the oil, gas and mining. The decisions made by to invest capital in developing high technology industries and spurring the development of telecommunications and space related business has been very successful.

Colorado currently has an unemployment rate of between 2 and 2½ percent and our biggest worry is getting qualified capable workers for the industry. The challenge for the states is to be able to provide an educated workforce that will allow companies to continue their growth.

The Federal government has played a critical role in the development of the remote sensing industry. This was led by Ken Gordon who was instrumental in developing the commercial data purchase program at Stennis Space Center. This was not a matter of funding but rather sending a signal to CEO's that this type of activity had government approval. There is more that can be done including regulatory reform. The transfer of authority to the State Department has had a very debilitating effect on our ability to compete with companies off shore. This was brought out most recently in Mr. Rumsfeld's confirmation hearings.

Mr. Pagliosotti said, in summary, that he truly believed that commercial space has a tremendous, exciting future and that the people working in the House and Senate staffs as well as Patti Smith and her team in AST have done a tremendous amount to make it happen.

The next speaker was Mr. Ken Gordon, Director of Space Policy a the Aerospace Corporation.

Ken spoke saying that this report marked the end of space as a special activity. It is the end of rationalizing the space program because it is only for the good of the country. He said that it has been common to say that the space program is most noted for the number of spin-offs from investments in the space program. This included spacesuit materials such as flame retardant pajamas for kids. But wouldn't it have been cheaper to develop the material without going into space?

He went on to say that the return on the government investment in space is often $6 or $7 for each $1 spent. But people don't care. Government is not in the business of making money, that's for the private sector.

The space sector of the aerospace industry needs normalization. What is so wonderful about this report is that it gives us an ability to quantitatively look at the commercial space as just another business sector.

Looking at the numbers within the report Mr. Gordon decided to compare the space sector to other sectors to see how they compare. Within a Department of Commerce report on gross domestic product were breakdowns on how different sectors contribute to the gross domestic product and this provided a fair comparison.

Farming sector about $ 74 billion of GDP is about twice the amount of aerospace, but not nearly the influence of farmers. Tobacco is $19.9 billion which is about half of commercial aerospace. The President mentioned today mentioned textiles and that industry is $25 billion worth of the gross domestic product, which is a bit over half that of aerospace industry.

We have our problems to solve, Ken said. Everyone is worried about export controls and recently there was a battle over indemnification which was won but may still be coming to an end. Range modernization is also an issue pressing on our minds. We are bigger than big tobacco. Why doesn't the Hill tremble when we come calling?

The people in California and Florida have always felt that they were the aerospace states and that nobody else cares. That's why the report is so important and I praise Patti Smith and her office for commissioning this report and taking our industry to a place where we can think of ourselves as an integral part of the economic system.

The world thinks about trade – about surplus and deficits. And Bruce Mahone at Aerospace Industries Association has been doing yeoman's work convincing the world that the aerospace sector is the number one trade surplus sector in our economy. And we also need to think about how many jobs this industry represents. That's the message that we should send.

Breaking down the jobs category shows that there is an average of 220 electronics jobs in each congressional district working on aerospace activities. Members of Congress care about 220 jobs.

Where do we go from here? There are a number of challenges:

1. To the States and the FAA to look at not only the entire United States but at each congressional district.
2. To the Satellite Industry Association to look at business losses and how that affects each congressional district.
3. The Satellite Industry Study done for California should be done for each state.
4. To the Aerospace Industries Association who should continue to press the issue of the trade deficit and how it can be impacted district by district.

Finally, Ken issued a challenge to the Aerospace industry to continue to support and provide financial funding to the associations represented here today so they may continue to carry out their tasks.

This concluded the presentations on the Economic Impact of Commercial Space Transportation on the U. S. Economy.

SUMMARY OF THE SPACE WEATHER PANEL

As spacecraft extend their operational life on orbit, as launch vehicles, particularly, future reusable launch vehicles, extend their overall time on orbit, and as we begin to consider the carriage of passengers, space weather becomes more and more significant. This panel on Space Weather presented different perspectives on Space Weather, what is Space Weather (Joseph M. Kunches, the Acting Chief of Operations and Lead Forecaster at NOAA's Space Environment Center at Boulder, Colorado), space weather impacts (Captain Kelly M. Law, Space Environment Officer of the 55th Space Weather Squadron at Shrever Air Force Base in Colorado) and health aspects of radiation exposure during space travel (Dr. Wallace Friedberg, leader of the radiobiology Research Team at the FAA's Civil Aeromedical Institute).

The first speaker was Mr. Kunches. Mr. Kunches remarks and charts covered the radiation belts, and what the sun is producing in terms of energetic particles that is the weather of concern for these space travelers. He talked about what is space weather, how do you know it when you have it, what does it affect, and how you can get information about space weather.

As different technologies evolved, such as GPS, and telecommunications technologies, it was found that there was not a void above the terrestrial atmosphere but, in fact, this is a very dynamic place that is very changeable and very influential on the proper function of many of those systems.

So, the technology is driving much of the concern for space weather. There is an increasing cognizance by the general public that space weather exists, that so-called solar storms occur, and periodically you get a brilliant display of the Northern Lights, even from places like Washington, D.C.

We have found that there are instances where solar activity and space weather do affect people in an airplane or flying in the international space station.

Solar flare protons affect those in the Space Shuttle and satellites in terms of damaging their solar cells. Other effects are due to electrons, energetic electrons that can penetrate into the dielectrics of satellites and cause what's called deep dielectric charging or volt charging. Solar photons, the extreme ultraviolet in x-rays affect the ionosphere, and it's the ionosphere that, for example, GPS signals have to pass through as they go from the satellite to the ground. The ionosphere is a reflective wave-guide for high frequency communication from about three to 30 megahertz. That is affected by space weather.

The ionosphere can be very turbulent resulting in amplitude or phase scintillations of satellite signals as they come to the ground. The net result is problematic reception of those transmissions from the satellite to the ground.

Airline passengers are becoming more aware of radiation. If you fly over the poles, through the polar cap, the area of the earth's atmosphere that is most accepting of the solar wind that comes from the sun.

Space weather can actually have an effect right here on the ground. When the sun is very active and produces plasma and material that comes by the earth, those conditions can cause a magnetic storm on earth. The changing magnetic field during a magnetic storm induces a current. That current can flow through the ground. Depending on the geology on which a particular power grid sits that current may want to go to the ground or it may want to go back up into the power system itself. In the worst case, for example, in 1989 the power grid in Quebec, Hydro Quebec experienced a failure for nine hours, 6 million

people were blacked out because their grid failed in the course of a magnetic storm that was spawned a few days earlier by activity at the sun.

What drives space weather are solar emissions including photons, x-rays, extreme ultraviolet emissions, and solar protons, alpha particles, heavy ions, and plasma. The sun does what it does, and sometimes the earth gets in the way.

The sun has an 11-year periodicity called the solar cycle, and we are at the maximum of the solar cycle now. For people who try to make predictions 24 hours a day, seven days a week, about what is space weather going to be in the next day, in the next two days, it can be a terribly challenging problem. This is because (A) the sun is very far away from us; (B) when we see an ejecta come off of the sun there is a lot of uncertainty that the earth is going to be in its path; and (C) if it is in its path and the ejecta goes by the earth there is still a lot of uncertainty whether that energy, as part of that plasma cloud, couple into the earth's magnetic field and cause a large storm, for example.

We have to have more data to better understand and to better predict space weather and yet at times have too much data in some sense, and we need to know, now, wait a minute, can we better understand what we are seeing.

A picture of a prominence perched on the edge of the sun was shown. The structure was about 100,000 kilometers high. The material is suspended against gravity by magnetic fields, and when those magnetic fields become unstable then this material is released into the solar wind as a plasma cloud, and this is the kind of thing that should it go by the earth would cause adverse space weather.

A picture from the SOHO spacecraft shows very bright bubble feature extending a few solar radii out from sun. This feature is the expulsion of material from the sun called the coronal mass ejection. Now, in this particular example, this ejecta is actually going orthogonal to the earth and it is not something that we would have need to worry about. But, for forecasters, if you see one that looks like a halo, you would know that either this ejection is coming right at you or is going exactly away from you. With other data this ambiguity can be resolved and it can be determined whether the sun has ejected something that's coming towards the earth.

The Space Environment Center serves the civilian world. A wide variety of customers who are interested in space weather, including a lot of industries such as Satellite Operators, Launch Teams, Power Grid Operators, Telecommunication Companies and other Space Weather providers. The Center does not support DOD directly; it is not in the charter. The Center supports everybody else including other Civilian Agencies such as NASA, DOT, DOE, FAA and NOAA. The Center has a group of sister organizations around the world. They all cooperate and share data, share forecasts and to try to come to some consensus about a forecast for the next few days. The Center also deals with education of general public and media interest has made this very easy. When things get really busy, one of the big problems in the operation center is trying to keep the media at bay so it can focus on its primary job and then do the interviews later.

There is also private vendor community that is doing tailored space weather products for particular user groups. For example, taking space weather data, putting it in a form that is most useful to electric power grid operators and selling those forecasts and those tailored products to that industry.

A time line starting back in the 1940s shows the solar cycles and the customers who have become interested in space weather and when they became interested. It shows what technology was being born that found an academic or practical interest in that space weather. For example, radio communications, HF radio communications interest goes way back to World War II, and today satellite cell phones and things like the GPS system have an interest. The list keeps adding onto itself. Nothing really seems to go away. Maybe ten or 15 years from now commercial space transportation would be a very interested customer wanting to know what are the conditions in space today.

The Space Environment Center's web site (http://sec.noaa.gov) contains up-to-date real time space weather information. Some of it is fairly scientific, but other parts of the web site are pretty much self-

explanatory. There are a number of ways that the Center has tried to help the general public understand the message that it is trying to convey.

The next speaker was Captain Kelly Law, Space Environment Officer of the 55th Space Weather Squadron at Shriever Air Force Base in Colorado.

Yes, Space Weather will affect you. Before getting to some basic examples, an explanation of space weather using analogies is helpful. The presentation started with a quick recap of space weather, then its impacts, followed by some examples of some storms that occurred within the year. Next Captain Law discussed mitigation, although there's not much you can do about some things. *I*t is nice to know what is bothering you, so you don't waste your time worrying about the wrong things.

Without the sun we wouldn't have space weather. There are 93 million miles between the sun and the Earth. When something happens on the sun, it is going to send off extra energy, and it has to get to the earth somehow. There are three different ways it gets to the Earth.

Some of the energy leaves quickly and it gets here almost right away. Call that NOW as in "right away." That is the electromagnetic energy that travels at the speed of light; it travels 93 million miles pretty damn quick and it gets here in about eight minutes. But guess what, all our sensors are here, so by the time we see it it's already here. It is already affecting our communications; it is already bothering our systems. That is the NOW.

There is some other stuff, call it SOON, meaning not quite as NOW. Sometimes an event on the sun sends out a little bit of extra stuff, not just quite electromagnetic energy, not just a radio burst, but particles, and those particles are almost traveling at the speed of light, almost, and they get here SOON. They are like little bullets, and that screws up stuff on earth (see below). That's the SOON stuff.

CME stands for coronal mass ejection. Say the sun vomits and decides to send off, not just a little bit of light energy, not just a few particles, but actually some of the Sun's surface, blown off the surface coming at the Earth. It must to travel 93 million miles, but it does it in a spectacular way. Its speed is not even close to the speed of light and it's going to take days to get here. And we're going to forget about this event until a few days later when it hits the earth. That is the LATER stuff, and it's almost the more fascinating stuff, because it's subtle. It looks innocent, it looks innocuous, but it will bother us for quite some time.

The reason to talk about NOW, SOON and LATER is that it is a way to describe the impacts. A simple rule of thumb, "what gets here quickest is over soonest." If it's light energy, and it gets here right away, it's over with pretty quick, a matter of hours. So, when we get the radiation, whether it is radio or x-ray, it bothers us just a little while.

If it is a proton, it arrives almost immediately, soon, but it can bother us for many hours to days, and if it takes days to get here it can bother us for quite a long time, several days.

This is actually something that falls into the ANYTIME category. It is somewhat related to the sun, but it is really an Ionospheric phenomenon. We communicate with HF radio with that layer of thinly ionized plasma above our atmosphere. Different densities of plasma, 1,000 kilometers above your head can move at 300 or 400 knots. That is scintillation, and when that begins to move around that is what can break up satellite communications. So, that's an ANYTIME thing.

Now, light or radio energy that gets here within eight minutes, almost instantaneously, the big thing it does is something called a short-wave fade. HF is kind of important and it depends on the ionosphere. When extra energy comes from the sun and hits the Earth immediately, it changes our ionosphere, and it screws up all your communication plans, particularly, and only in the sunlit hemisphere of the earth. So, if you are in daylight and an x-ray flare happens, or a radio burst happens, short-wave fade can affect your HF communications. Is that important? Ask the AWACS pilots flying over Iraq or Saudi Arabia.

Again, short wave fades, instantaneous impact, sunlit hemisphere of the earth only. For example, over the horizon radars that are sitting in the dark but looking into the daylight will also be affected.

SOON, those little particles describe as bullets, protons generally, high-energy protons coming from the sun when it gets a real energetic flare and they get here 15 minutes to an hour later, they cause some impacts almost right away.

These high-energy protons can cause damage to our satellites, to the solar panels. A storm this summer that may have damaged the solar panels on one of the GOES satellites we use for weather.

It can also cause satellite disorientation. Stardust experiment was going to go look at a comet was disoriented. Its star sensor was looking at the stars and knows what they are supposed to look like. Those little protons come and hit the sensor causing little white dots that look a lot like stars. The satellite starts thinking, man, where did that one come from, and then starts to look for all the others. The next thing is that the satellite is talking anymore.

Launch payload failures, Titan, Atlas launches, very concerned with protons and the damage proton events can cause during a launch. The Space Environment Center has a specific requirement to let NASA know when certain proton levels are reached, because they would have to stop floating around outside of the spacecraft. Protons cause a lot of problems.

The LATER impacts, the ones that are lazy, innocuous, seemingly harmless, but not really so, that cause geomagnetic storming. These are the cool ones.

An event happens on the sun, a shock wave, coronal mass ejection being blown off into the solar wind, increasing the solar wind speed maybe 1,000 kilometers per second, instead of, say, normally 200-300. The Earth's magnetosphere, the extension of the earth's magnetic field lines into space makes a bubble around the earth and kind of protects us. It's a good thing it's there for us. All this stuff comes from the sun and hits the magnetosphere, and it cannot go through the field lines, it has to go around in the back door. Those particles go to the magneto-tail, the very end of our bubble that protects us, and come in the back door. The weird part about this geomagnetic storm is that the stuff from the sun begins to bother us from the night side of the earth.

What happens when it gets into our magnetosphere, it gets inside our radiation environment, our radiation belts, it bombards us, comes into the polar caps, comes into the equatorial regions, and in the polar caps it streams down the magnetic field lines of the earth. It usually starts at local midnight. One can almost imagine the particles streaming down those lines, like a curtain, right into the lower regions of our atmosphere.

What else does it do? It fills up our radiation belts. All of a sudden it is full with a lot more electrons, a lot more protons, and we have charging. If a spacecraft is moving along in an environment that is suddenly full of a lot more electrons, a lot of negative charge builds up on one side, a lot of positive charge on the other, and things have to discharge.

In outer space you have a change in solar illumination, a change in the way the vehicle is oriented, or a command from the ground station. These things can cause the discharge. A potential is built up and, for example, when someone tries to talk to that satellite, "BAM", something happens.

Sometimes if it's flying in an environment long enough (e.g., 3 days), the charge disparity does not take place on the surface but inside. This is called deep dialectic charging. When the discharge happens it is on the circuit boards, it is causing all sorts of problems.

Space is not a vacuum. When there is a geomagnetic storm, the atmosphere heats up and it expands. Because it expands it changes the density at low earth orbit, which means all the calculations about how that orbit is going to naturally decay are affected, because now things are different densities. As

an example there was a huge storm in March of 1989 that caused the blackout in Canada. It changed our atmosphere drag parameters at low earth orbit. It was not expected and NORAD, which tracks objects in space, lost track of a few things. It was a fairly strong storm with an AP of 160 or 170 on a scale of zero to 400. NORAD lost track of nearly 1,400 objects, because of that storm. It took them two weeks to find all of them again.

Ionospheric scintillation bothers transionospheric communication. Particularly UHF, SATCOM frequencies, and to a little extent GPS. For UHF and those blobs of plasma run over your line of sight, there are going to be problems. It is very nice to know when that scintillation is happening so that we don't think we are being jammed by people who don't like us very much.

The March 1989 mother of all storms that blacked out Canada is probably not going to happen again because the power companies now take steps to prevent it. Over 1,300 objects are lost at NORAD, which is bad. Worldwide HF communication blackouts, that's bad, too, for airlines for example. We have a nine hour Canadian power outage, but they can burn wood. Loran navigation has problems, there are compass alignment problems, and a lot of satellites require more orbital corrections than are normally needed in a year, in a few days. Imagery is lost from some of our satellites. Interference occurs at six missile warning radar sites.

So, yes, the sun does affect us. It does impact us, and we care, that's why there are military weather persons doing space weather, because the military does care.

Let's go over some recent cases. A flare happened at 10:03 Zulu time on the 14th of July, almost 40 minutes after that we started getting the protons, and about a day later, which is pretty quick actually, we got those little innocuous particles that caused all the storming. Almost immediately, the x-ray spike was the NOW, the electromagnetic energy being recorded at low earth orbit by the GOES satellites. NOW - that was the instant stuff. Almost right after that, the protons increase, so suddenly we've gone from, we're fine, to, oh, my God, we've got protons everywhere. And then, about a day later KP geomagnetic storming. That is just a quick example of one event causing three different problems in time over a period of days.

When we had the NOW, there was HF communication problems. When the protons came, there was concern about radiation and satellite damage. When the storming happened, there still was concern about radiation damage and charging problems with satellites, etc.

These are some of the impacts that happened. Obviously, HF went out, people couldn't talk. There were reports from, perhaps Europe, where communications went out for over 80 minutes on certain frequencies, everything from, basically, below 25 megahertz was unusable.

SOON, the protons, GOES, their sensors are saturated. They were toast; they could not be used. Navigation imagery, SEU, star tracking problems, single-event upsets, and other star tracking problems were reported on other geosynchronous satellites. Three New Jersey power plants, Salem I and II and Hope Creek went to 80 percent capacity because the transformer blew due to this storm from the ground-induced currents. GOES had a drag problem, that obviously required correction, burns up fuel, that sort of thing.

And SOHO, which gives optical imagery of the sun through a variety of filters, lost about a year of its lifetime because of the damage to the solar panels.

Other impacts we received from the field included single-frequency GPS errors. GPS errors went from about 6 meters to almost 13 meters.

Thanksgiving, November of last year, was very unusual event, in a matter of 72 hours we had eight major solar flares. Usually there is one, not eight, and five of these were in the extreme category - very strong flares. Also in conjunction with the flares, there was a coronal mass ejection. It ejected

material into the solar wind about 1,000 kilometers per second. Basically, communication on anything below 15 megahertz was probably not working for some time.

There were impacts from military customers, Navy ROTHR went out 28 megahertz and below for over an hour, same thing with the Chesapeake Coast Guard Station, everything 20 megahertz and below, out for over an hour.

What about mitigation? If you are communicating in HF, and there's a solar flare and you actually know about it, you could change your frequency. You could switch to a higher frequency. Well, you hope the guy you try to talk to does the same thing. You could change your schedule, but sometimes combat doesn't allow for that. For satellite communications, again, switch to a frequency but you have to coordinate things on that. Rule out equipment problem is one of the biggest advantages of knowing a solar event has happened.

If GPS goes out, and you can no longer communicate SATCOM to GPS, what are you supposed to do? Use lensatic compass map and protractor.

Warning people their HF Communications are going to go out and how long it is expected to last is helpful. When a radio burst occurs, radar sites are informed so they don't freak out. For Ionospheric scintillation, people are informed, depending on what region of the world they are located.

The last speaker was Doctor Wallace Friedberg who discussed the health aspects of the radiation exposure on a 2.5-year Mars mission and on a 9.8-day Shuttle-Mir mission.

Commercial activities in space will expose men and women to higher doses of radiation than they ordinarily would experience in the atmosphere of the earth.

First, it is important to define the Sievert, a radiation term. It is a measure of the biological harm from radiation. A Sievert is a 100^{th} of a rem. The Sievert takes into account the fact that equal amounts of energy deposited in an individual from different types of radiation -- for example, neutrons and photons -- are not equally harmful. For example, a trip from Washington, D.C., to Los Angeles might expose someone to .02 milliSievert (mSv), and a chest x-ray is about the same.

Consider a 2-1/2 year mission to Mars during solar minimum. The crew spends about one year in transit (outbound plus inbound), and the radiation dose received from the so-called galactic cosmic radiation is 727 mSv. During the 18 months on Mars, the crew receives galactic radiation, 407 mSv, and from a solar energetic particle event radiation, 24 mSv, and the total mission dose was 1,158 mSv. These numbers are based on a trip during the solar minimum stage of the 11 year solar activity cycle, and that's where there's a relatively small chance, at least compared to solar maximum, of a large solar energetic particle event.

The dose to the crew from galactic radiation could be reduced if the mission occurred during solar maximum. However, the crew would be at a higher risk of being irradiated with solar particle radiation during one or more solar particle events. So, if you want to avoid a solar energetic particle event, at least the chance of one, you have the flight during solar minimum, but you get a higher galactic radiation, but that's easier to handle.

One of the big concerns of space radiation and space travel, as far as the radiation, is the long-term effects, and that is cancer. Radiation up there is a lot different from the radiation where we get most of our data (e.g., from the bombing of Hiroshima and Nagasaki). A lot of expert committees have made judgments so we can come up with some kind of estimates of doses, but there are epidemiology studies ongoing, some have been completed, and it's going to take years until we really know what's going on. But, this is the best estimate, and it's probably not too bad.

We've looked at risks of cancer, and we've looked at it two different ways. One is to use a risk coefficient of four in 100,000 mSv, for adults. This means that if 100,000 adults were occupationally

exposed to 1 mSv of radiation, 4 of these individuals would be expected to die of cancer from this exposure. This does not take into account that men and women have a different sensitivity to radiation, and that there is an age difference. Based on these assumptions, the expected mortality from cancer for the crewmembers exposed to 1,158 mSv is 4.6 percent.

Another method takes into account the fact that the risk of radiation-induced cancer varies with age at exposure and gender. Young women have the highest risk because of their greater sensitivity to radiation-induced cancers of the thyroid and breast, and because on the average they live longer than men and risk is assumed to continue to the end of life for all cancers except leukemia. Taking in account age at exposure and gender in estimating risk, women in the 25-34 year age group would incur a lifetime risk of fatal cancer of 6.9 percent. If they were in the 45 to 54 year age group and they were men, the risk is only 1.7 percent. So there is quite a bit of difference whether you are a man or woman, and what age you are when you were exposed.

In the general population, about 24 percent of adults in the United States eventually die of cancer, and so if you want to know your risk of dying of cancer is, if you are a crew member, a good guess is 24 percent, plus any risk from occupational exposure.

Now, if a crewmember is inadequately shielded during a solar particle event, bad things can happen. They can experience life-threatening early health effects. For cancer it is usually years from the time you are exposed, but here effects could happen within a month or so, or in hours if you get a high enough exposure. Unless there is a solar particle event this kind of thing does not happen, because the exposure is usually over a long period of time, and it's less harmful.

People differ in how they respond to radiation. Between 500 to 3,500 mSv, vomiting occurs within two days, and that can be really threatening to a mission. A whopping dose between 2,000 to 4,000, a potentially lethal infection can occur, severe bleeding in tissues and organs, and possible death within 20 to 40 days.

If you are on earth, there are all kinds of medical treatment one could give, but there are limits. The experience of Chernobyl, where a lot of people died, involved the selection the people to receive bone marrow transplants, because some people it just wouldn't have worked anyway, you know. Between 3,200 to 5,400 mSv, half the people that received that kind of dose will die in about a month if they don't receive any transplant or bone marrow. Providing this treatment on space vehicle, or on Mars is not likely.

There are other effects and they are not mission threatening. There is an increased risk of cataracts. Radiation causes cataracts. Many people get cataracts anyway. By the age of 65 it is estimated about 90 percent of people have some form of cataract. It may not limit vision so that it is really noticed some opacity of the lens has occurred. There are combined effects, irradiation plus getting old, results in a much higher risk of a cataract.

This is a stochastic effect; it means the chance of getting it increases if you have a higher dose of radiation. There's an area called radiation hormeis is, it is fairly widely believed that at very low doses of radiation it is possible that you may not have a risk of cancer, but this is an area that is still in research. Certainly, for certain effects that's true, whether it's true for everything is not known. We know that with certain effects it absolutely is not true. But with things like cataracts and sterility which are deterministic effects, a certain amount of radiation is necessary in order to get the effect, and the degree of the effect depends on the amount of radiation you get. The minimum acute dose to produce a cataract is about 2,000 mSv, and if you get radiation over three weeks or longer, the minimum dose is 4,000 mSv, or higher even. It depends on individuals. This means that a cataract from a particular dose of radiation is less likely if the dose is spread out over a reasonable long period of time.

Now, the appearance of a cataract is between six months and 35 years of receipt of the irradiation. So it is not likely to have much effect on the mission. Following acute doses of 2,500-6,500 mSv the latent period is about eight years and the latent period becomes shorter as the doses increase.

Sterility is another area that is not going to affect the mission, but it certainly is of concern to crewmembers. In men, the minimum acute dose to the testes to produce temporary sterility is about 150 mSv. A dose of 1,000 to 3,000 mSv would produce temporary sterility for a year or longer. For permanent sterility the minimum acute dose is about 3,500-6,000 mSv. Induction of sterility by radiation does not significantly effect libido or potency. If a person had a whole body exposure, they probably would die of who knows what including bleeding, or bone marrow depletion, or infection.

In women, the minimum acute dose to the ovaries to produce permanent sterility is 2,500 to 6,000 mSv. Pronounced hormonal changes, comparable to those associated with natural menopause accompany radiation-induced sterilization.

In looking at the flight profile for the 9th Shuttle Mir mission flown in 1998, at an orbital inclination of 51.6 degrees it was protected partially by the earth's magnetic field. When you get north of about 50 degrees there is very little or no protection from the earth's magnetic field. The altitude was about 400 kilometers, and in 90 minutes it flew around the earth. At that altitude it did get radiation from the Van Allen radiation belts, but only at the South Atlantic anomaly, where the belts actually dip down. Therefore did not get radiation from the belts the entire orbit.

The travel from the Kennedy Space Center to Mir took 1.8 days, and it orbited the earth with Mir four days, and the return to Kennedy Space Center was another four days. The total mission length was 9.8 days. Now, the radiation dose was 4.1 mSv. That is a lot less than the one we described for the Mars mission.

Estimates of the risk of cancer can be made using the same methods that was used with the Mars mission. Ignoring the age at exposure or the sex of the crewmember, based on a dose of 4.1 mSv the estimated risk, percent mortality, for that 9.8 day mission was .016 percent.

Whenever a person is exposed there is a risk of serious genetic defects. Consider a child conceived after one of the parents was exposed to radiation, based on the mission doses that were presented earlier. In the case of the Mars mission, 1,158 mSv, the estimated percent risk to the first generation, the child, is .13 percent, and for the Mir mission it is .0012 percent. It is very small.

There is a lot of uncertainty about genetic defects. We do not have good data in humans; estimates are mostly based on animal data. But there's no question in anyone's mind that radiation causes genetic defects.

Doctor Friedberg believes that space ventures involving civilian crews and tourists can meet reasonable radiation safety standards. However, there will have to be some travel limits, and in the case of deep space missions, perhaps, some changing of the recommended limits. Deep space missions could not meet the standards that are recommended for airline pilots, for example, 20 mSv per year average, and a maximum of 50 mSv in a single year. Airline pilots do not even get near those limits (less than a third). Pregnant crewmembers, however, can, if they fly a lot can bump into the limit of one millisievert a year. Of course, some of this may have to be changed on space missions because of the whopping doses that the embryo could potentially get, and the embryo did not ask to be there.

On the near earth mission, current radiation standard limits would not be exceeded if crew members did not fly more than only a few short missions a year, like the shuttle Mir mission. On that 9.8 day mission, the radiation dose was 4.1 mSv. If they flew five such missions that would be 20.5, and that's pretty close to the recommended limit of 20.

A tourist can fly one such mission every five years. Every five years a tourist would be allowed about five mSv in five years. The limit is higher than the 4.1 that was estimated for that mission. So, tourists would not have any problem on near earth missions.

Now, on the two-and-a-half year missions to Mars, we have another situation. The estimated dose of 1,158 mSv to crewmembers clearly exceeds recommended limits, and the limit would be 50 mSv in a

single year. Even if there were not a solar particle event, the recommended limit would clearly exceed. In that case, radiation limits for deep space missions would have to be increased if they were to take place. It would seem reasonable to limit crewmembers to one mission of this magnitude in a career. Also, maybe assign older individuals to this type of mission, which probably would happen anyway because they are more experienced.

Tourists should be excluded from such missions, for obvious reasons. A woman who is pregnant should not go on any space missions because of the sensitivity of the unborn child to radiation, and because that 4.1 millisievert, on a near earth mission, clearly exceeds the one millisievert limit for the fetus.

Finally, it should be recognized that current knowledge about radiation-induced health effects is essentially limited to earthbound experience, and quantitative information about these effects usually includes a wide range of uncertainty. One can only speculate as to possible combined effects of radiation exposure and other factors in the space environment.

SUMMARY OF ECONOMIC ISSUES PANEL

Panel Moderator Esta Rosenberg introduced panelists Michael French, Vice President, ING Barings, Satellite Research Group, and Steven Wurst, President and CEO, Space Access

Mr. French discussed means of attracting investment capital, and described the current investment climate in general and for satellites and satellite services in particular. Overall, the economy is in a downturn and financial markets are undergoing a retrenchment to come up with better ways of evaluating companies and achieving stable growth. New factors, such as those introduced by the Internet, are affecting the market.

Generally, the marketplace seems to finding a bottom point and there is some evidence that the markets are beginning to turn around. In the last 6-8 months, financial markets have experienced a cessation of "deal flow," that is, new issues or other transactions involving investment banks, but the market appears to be ready for a rebound. In terms of satellite financing, the only recent transaction was for New Skies, and that was driven by legal requirements.

The current strategy for attracting capital is to seek venture capital. In the space industry, vendor financing is particularly important. Mr. French forecasts that the satellite industry will in the next several weeks and months experience consolidation and mergers and acquisitions, in addition to potentially some types of private transactions.

Mr. French identified the following factors in terms of ability to attract investors:

- Management personnel, and the CEO in particular;
  - Track record of those personnel;
  - Sound and effective presentations that instill confidence and trust and an investor's sense of management competence;
- Earnings potential, with an articulated clear path to profitability and earnings potential;
- Strong market position, as demonstrated through a unique plan or barriers to entry by competitors (e.g., financial hurdles and regulatory barriers);
- Clearly articulated exit strategy and means of evaluating the terminal value of a business.

Factors that inhibit capital investment include:

- Absence of the positive factors identified above;
- Adverse market conditions;

• Uncertainties in the business (e.g., technology unknowns, litigation, new regulations, assured market access and legal hurdles).

To attract capital, Mr. French suggested utilizing the following tools:

• Have a good, clear and simple presentation and excellent presenter;

• Identify and target the audience (e.g., private debt vs. bank debt) and find the right mix taking into account regional differences in investor style (e.g., west coast/east coast investors who buy and sell rapidly vs. midwestern stability).

In forecasting the future, Mr. French noted that although the markets have been closed recently, he expects to see new offerings, possibly those in the space sector, coming to the financial markets.

Mr. Steve Wurst, president of Space Access, addressed the issue of financial incentives for the aerospace industry. Despite the importance of aerospace to the nation's economic success and national interest, Mr. Wurst noted the recent decline in US leadership in aerospace. Key to achievement of national goals will be how aerospace is prioritized, in terms of defense, civil and commercial sectors. Mr. Wurst urged reversal of recent trends, that is, of government direct funding applying first to military and civil programs with a carryover into the commercial world. Rather, Mr. Wurst urged that investment be directed towards the commercial sector with a carryover to the military and civil sectors, so that commercial is out in front. The commercial world will enable end goals and will pay for itself.

To illustrate his point, Mr. Wurst pointed to NASA's technology development program for second generation RLVs. He noted with concern that the finance industry's perception would be that the government is competing with entrepreneurial commercial launch service providers thereby precluding commercial investment. The government would own rights to the technology.

Mr. Wurst's vision for the future, given the new Administration, is to commercialize space in seven years by funding to provide government financial incentives to commercial developers through such vehicles as loan guarantees to facilitate expansion of space transportation infrastructure. He urges loan guarantees because they allow commercial developers to identify and develop the best systems that are most commercially viable, thereby enhancing competitiveness and lowering costs to end users. With a loan guarantee program under which a developer must finance at least 50% of the program, multiple RLV systems could be developed and would be competitive, without government expenditure (although there would be a capital reserve for defaults). Loan guarantees further provide an incentive for a developer to stay within cost, budget and performance goals. It is also necessary to develop strategic partnerships for investment and loan guarantees facilitate doing so.

Mr. Wurst pointed out the need for financial incentives for commercial aerospace development that are consistent with the goals of the new Administration, and its tax plans in particular.

As an interim solution, Mr. Wurst suggested that NASA and DOD direct funded contracts facilitate commercial ownership. To ensure this result, the government should avoid emphasis on government direct funding for the acquisition of technology from industry. Instead, government funding should be focused upon the validation and certification of commercial solutions. Industry would provide test articles and the government would fund their validation and certifications consistent with standards and specifications established by governing authorities and customers, including satellite customers, NASA and DOD. The government would acquire the rights to test data but not necessarily the underlying technologies and test articles. He suggested that this approach would work through incremental build up, beginning with materials and subcomponents and then advancing through subsystems and systems. The end result would be a competitive supplier base at each level, as large as the commercial market can support.

During the question and answer session that followed—

Chuck Lauer, Pioneer Rocket Plane, disagreed with Mr. Wurst regarding loan guarantees. He pointed out the lack of industry consensus on loan guarantees and the failure of the Breaux legislation as a result. As an alternative solution, Mr. Lauer suggested using investment tax credits, asserting that they are

more market oriented and more conducive to private sector underwriting and scrutiny, they don't limit the field to two companies to receive all the benefits (much like Boeing and Airbus), and are neutral in that the government does not select who gets the benefits. An investment tax credit flows to investors and is therefore more market-oriented a solution.

Mr. Wurst disagreed but noted that the common element between loan guarantees and a tax credit is determining eligibility and that should reside in the Department of Transportation. Eligibility should be based upon a technologically feasible approach and a business case, according to Mr. Wurst. The concern on tax creidts is the absence of government control over how much gets invested in any one year.

When asked, Mr. Wurst stated that he believes a market does exist for multiple RLV investment and development, particularly if RLVs demonstrate reliability.

Regarding XM satellite radio and Sirius, Mr. French noted its progress and the efforts being made to test it out. Sirius experienced a late start but in the next year, products such as these are going to be very compelling and a market exists for them.

SUMMARY OF THE PANEL: New Technologies: What's on the Horizon and Where Will It Take Us?

Summary of the "Space Launch Technology: What to Expect (and What NOT to Expect) Over the Next 20 Years" Panel

Randy Repcheck, a member of the Licensing and Safety Division in AST, introduced the two members of the panel: Karen Poniatowski, Acting Deputy Associate Administer for Space Access, NASA; and Antonio Elias, Senior VP, Advanced Programs, Orbital Sciences Corporation.

Karen Poniatowski discussed the Office of Space Flight's Space Access Office, NASA's launch alternatives, NASA space access requirements, NASA's integrated space transportation plan, and NASA's space transportation considerations. The Space Access Office is responsible for the acquisition and management of all space transportation services for NASA and NASA sponsored payloads, including the space shuttle. It identifies and aggregates launch requirements, chairs the Office of Space Flight's Flight Planning Board, and provides policy direction to the program offices.

Under the Launch Services Purchase Act, NASA is required to buy launch services from the commercial sector unless they are not available or cost effective. NASA may then use other sources, including foreign launch services if a domestic option does not exist.

NASA's space access requirements are projected to total about 15 payloads per year through 2010, including the space station and space shuttle flights. The majority are scientific or earth science free flying spacecraft. Two to three per year would fall in the small class, four to five would fall in the medium class, and one to three would fall into the intermediate or EELV class. About six flights of the space shuttle are required through 2006, and four to five are required after that for re-supply to the space station.

NASA's integrated space transportation plan is an integrated Agency plan to meet the Agency's goals for safe, reliable, affordable access to space. NASA's approach is to maintain its existing fleet of launch vehicles and, at the same time, invest in the future. NASA will continue to utilize a mixed fleet launch strategy consisting of the Space Shuttle, ELVs, and emerging new RLV systems. NASA's focus is on safety, reliability, cost, and NASA mission requirements while maximizing US aerospace industry capabilities and commercial market leverage. Risk reduction for second generation RLVs is where NASA is focussing its efforts. NASA is working with industry to identify the key technologies that require risk reduction.

NASA approach to commercial launch services has been to buy six fixed-priced launch services from the commercial community. The latest types of contracts have been indefinite delivery, indefinite quantity. NASA views these as useful if you have multiple suppliers with overlapping capabilities, because NASA benefits from real competition. They also speed up the acquisition process as mission needs are identified. Due to the cost and unique nature of NASA payloads, NASA balances the risk that missions can tolerate with launch vehicle demonstrated flight history and maturity. NASA also has a team of engineers that provides technical oversight in mission integration to improve the probability of mission success. This same philosophy will be used in NASA's next set of acquisitions where reusable options will be looked at.

Antonio Elias reviewed the seven major technology elements that may significantly affect orbital launch services in the next 20 years. His focus was on reusable launch vehicles (RLVs). He stated that the seven most important technologies are:

- Reusable Composite Structures
- Composite Cryogenic Fuel Tanks
- Zero-Maintenance, All-Weather Thermal Protection Systems
- Peroxide or Cryogenic Auxiliary Propulsion
- Peroxide Power Units
- All-Electric Actuators and Power Distribution
- Integrated Vehicle Health Monitoring and Diagnostics

Given the expected advances in these areas in the near term, the technology available over the next twenty years will support a factor of three reduction in launch costs via a two-stage highly reusable launch vehicle. He noted that flight experiments must begin immediately, and that the development of low-maintenance, high-reliability SSME-class engines must begin soon. To support his conclusions, he discussed what could be expected from the following technology elements:

Reusable Composite Structures

Increased use of composites in primary structures will improve structural mass fraction by 30% to 40%. Launch vehicle empty mass fraction will become more dominated by subsystem weights.

Composite Cryogenic Fuel Tanks

The use of composite cryogenic tanks will further improve the empty mass fraction of launch vehicles. The X-33's negative experience with composite cryogenic tanks is a normal event in the development of a new technology. We must, however, continue development and flight and ground testing.

Zero-Maintenance, All-Weather Thermal Protection Systems

We should expect significant improvements in thermal protection systems. We need zero or near-zero maintenance materials, and true all weather operations. Near-full-size development and flight demonstration must begin now.

Peroxide or Cryogenic Auxiliary Propulsion

With respect to main propulsion, we should not expect any major performance improvements over the Space Shuttle Main Engine (SSME). There should be significant improvements in reliability and maintenance costs. The main propulsion system should be the critical path item in any new development.

With respect to secondary propulsion, clean systems should be developed such as LOX/LH2 or peroxide. LOX/LH2 is high performance, but high risk. Peroxide is low performance, but moderate risk.

Peroxide Power Units; All-Electric Actuators and Power Distribution; and Integrated Vehicle Health Monitoring and Diagnostics

There is tremendous potential to reduce the maintenance required by subsystems. The principal new subsystem technologies include "All-Electric" vehicles (i.e. no more hydraulics), hydrogen peroxide auxiliary power units, and comprehensive integrated vehicle health monitoring. There is not single major "miracle," but many small benefits in weight, maintenance, and reliability could be made.

Lastly, Mr. Elias discussed configurations of reusable launch vehicles. Although not considered a technology per se, configuration and requirements are as important as technology. Single-stage-to-orbit (SSTO) is not a viable configuration given the technology we will have available over the next 20 years. A reusable two-stage-to-orbit (TSTO) configuration is the best approach. His example was the Langley Research Center "Biamese" Concept. Two attached vehicles burn parallel, and the first vehicle glides or flies back to the launch site. A reasonable expectation is a three-fold savings for NASA and a two-fold savings to commercial GTO services.

ADJOURNMENT